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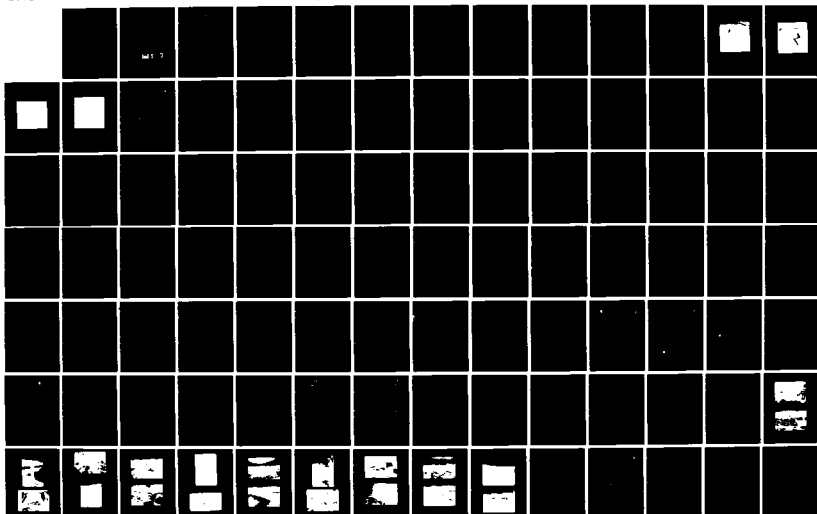
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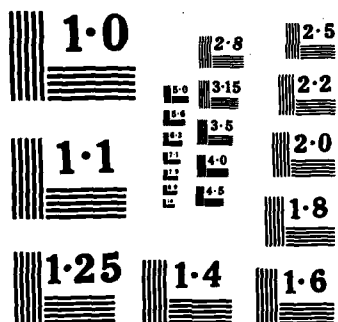
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AD-A155 799

**ANNISQUAM RIVER BASIN
GLOUCESTER, MASSACHUSETTS**

GOOSE COVE RESERVOIR DAMS & DIKES

NORTH DAM

MA 01098

NORTHWEST DIKE

MA 01099

SOUTH DAM

MA 00163

SOUTHWEST DIKE

MA 01100

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**



**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154**

APRIL 1981

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Annisquam River Basin Gloucester Massachusetts		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The North Dam is a 318 ft. long earth dam with earth dam with a maximum height of 34.7 ft. Generally the dam is in fair condition. There are deficiencies which must be corrected. The South Dam is a 551 ft. long earth dam. The dam is also in fair condition. Both dikes are in fair condition. They also have deficiencies which must be corrected.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

SEP 10 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Goose Cove Reservoir Dams & Dikes, North Dam (MA-01098) Northwest Dike (MA-01099), South Dam (MA-00163) & Southwest Dike (MA-01100) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is vitally important.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering, and to the owner, City of Gloucester, Gloucester, MA. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

GOOSE COVE RESERVOIR DAMS AND DIKES

NORTH DAM MA 01098
NORTHWEST DIKE MA 01099
SOUTH DAM MA 00163
SOUTHWEST DIKE MA 01100

ANNISQUAM RIVER BASIN
GLOUCESTER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

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NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA 01098 MA 00163
MA 01099 MA 01100

Name of Dam: Goose Cove North Dam Goose Cove South Dam
Goose Cove Northwest Dike Goose Cove Southwest Dike

Town: Gloucester

County and State: Essex County, Massachusetts

Date of Inspection: November 21, 1980

Goose Cove Reservoir was constructed in 1963 and is used for water supply. The reservoir is impounded by two dams and two dikes which are described below.

Goose Cove North Dam:

Goose Cove North Dam is a 318-foot long earth dam with a maximum height of 34.7 feet. The dam has a storage capacity of 1,138 acre-feet and is of intermediate size. The top of the dam is at Elevation (El) 80.2 National Geodetic Vertical Datum (NGVD). A drop inlet spillway containing a low-level outlet is located 70 feet upstream of the dam. The inlet contains four overflow weirs with a combined length of 20 feet at El 75.0. Discharge flows into a 36-inch diameter concrete conduit with an invert at El 50.0. The low-level outlet is a 24-inch diameter orifice controlled by a 24-inch square sluice gate.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dam is in fair condition.

The following deficiencies were observed at the site: erosion and tire ruts on the top of the embankment; small riprap dislodged from the upstream face of the dam; bent protective cover at the discharge end of the low-level outlet; seepage from beneath the low level outlet; a growth of brush and trees on the downstream face of the dam; brush on the upper ten feet of the upstream face of the dam; and an accumulation of debris in the downstream channel.

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove Northwest Dike:

Goose Cove Northwest Dike is a 472-foot long earth embankment with a maximum height of 45.2 feet. The dike has a storage capacity of 1,138 acre-feet and is of intermediate size. The top of the dike is at El 80.2. A toe drain discharges into a trench extending downstream from the dike.

There are deficiencies which must be corrected to assure the continued performance of this dike. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dike is in fair condition.

The following deficiencies were observed at the site: tire ruts on the top of the embankment; foot paths near the center and right abutment of the dike; a large rut filled with organic material near the center of the embankment; a heavy growth of brush and trees on the downstream slope; brush on the upper ten feet of the upstream slope; and an accumulation of debris in the downstream trench.

Goose Cove South Dam:

Goose Cove South Dam is a 551-foot long earth dam. The dam has a storage capacity of 940 acre-feet and is of small size. There is a 51.5 degree bend in the embankment at a distance of 360 feet from the right abutment. The dam has a maximum height of 17.1 feet and the top is at El 80.00. The spillway is a trapezoidal, broad-crested weir, 20.0 feet long, with the crest at El 78.0.

The low-level outlet is a 20-inch diameter concrete conduit that extends from a gate house on the upstream slope of the dam. The upstream invert of the outlet is at El 55.0. The outlet connects downstream to a pipeline that discharges into Babson Reservoir.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dam is in fair condition.

The following deficiencies were observed at the site: erosion from tire ruts on the top and downstream face of the dam; small riprap dislodged on the upstream face of the dam; growth of small trees on the downstream face of the dam; and a growth of brush on the upstream face of the dam.

Goose Cove Southwest Dike:

Goose Cove Southwest Dike is a 524-foot long earth dike with a maximum height of 9.3 feet. The dike has a storage capacity of 599 acre-feet and is of small size. The top of the dike is at El 80.3.

GOOSE COVE RESERVOIR DAMS AND DIKES

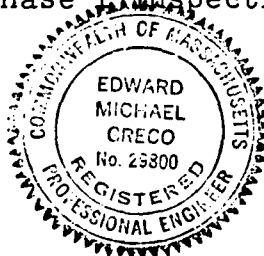
There are deficiencies which must be corrected to assure the continued performance of this dike. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dike is in fair condition.

The following deficiencies were observed at the site: erosion from tire ruts on the top and at several places on the downstream face of the dike; and a growth of brush on the top three feet of the upstream face of the dike.

Based on Corps of Engineer's guidelines, all of the dams and dikes have been classified in the high hazard category. A test flood equal to the full probable maximum flood (PMF) was used to evaluate the combined capacity of the spillways at the two dams. The test flood inflow is calculated to be 774 cubic feet per second (cfs). The test flood outflow is 416 cfs, resulting in a reservoir level at El 80.15. The test flood would only overtop the South Dam. The spillways can discharge a combined flow of 376 cfs or 90 percent of the test flood outflow before the South Dam is overtopped.

It is recommended that the Owner employ a qualified registered professional engineer to conduct a seismic analysis of all four embankments at Goose Cove Reservoir. In addition the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the dams and dikes during and after periods of heavy rainfall, and a plan for notifying downstream residents in the event of an emergency at any of the dams and dikes.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of 1 year after receipt of this Phase I Inspection Report.



Edward M. Greco

Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 29800

Approved by:

Stephen L. Bishop
Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.



Massachusetts Registration
No. 19703

GOOSE COVE RESERVOIR DAMS AND DIKES

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

GOOSE COVE RESERVOIR DAMS AND DIKES

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GOOSE COVE RESERVOIR DAMS AND DIKES

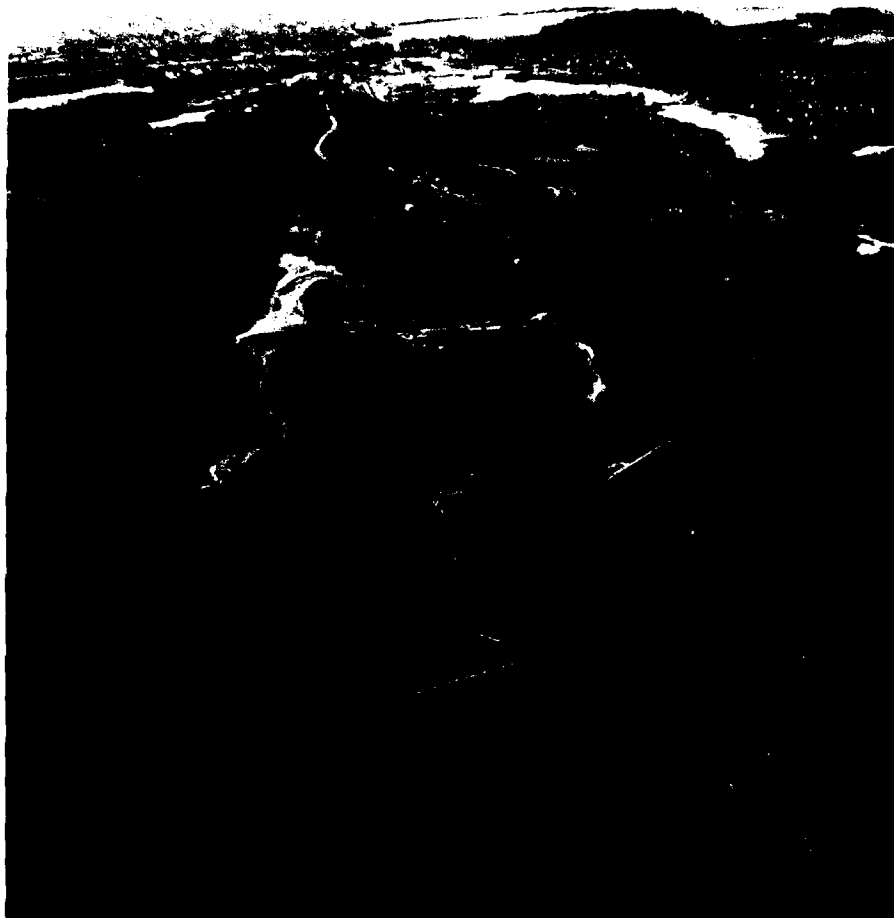
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OVERVIEW
GOOSE COVE RESERVOIR NORTH DAM
GLOUCESTER, MASSACHUSETTS

**SOUTH
DAM**

**NORTH
DAM**



**SOUTHWEST
DIKE**

**NORTHWEST
DIKE**

OVERVIEW
GOOSE COVE RESERVOIR NORTHWEST DIKE
GLOUCESTER, MASSACHUSETTS



- (2) Length of weir: 20 feet total
- (3) Crest elevation: 75.0
- (4) Gates: None
- (5) Upstream channel: N/A
- (6) Downstream channel: 36-inch dia. concrete conduit
- (7) General: None

Goose Cove South Dam:

- (1) Type: Trapezoidal, concrete, broad crested weir
- (2) Length of weir: 20 feet
- (3) Crest elevation: 78.0
- (4) Gates: None
- (5) Upstream channel: Upstream embankment slope
covered with - riprap
- (6) Downstream channel: Downstream embankment slope
covered with stone
- (7) General: None

j. Regulating Outlets

Goose Cove North Dam:

- (1) Invert El: 50.0
- (2) Size: 24 in. dia. orifice discharges into a
36 in. dia. concrete conduit
- (3) Description: orifice at base of drop inlet and
conduit leading out of drop inlet
- (4) Control mechanism: sluice gate operated from floor
stand on deck of vertical shaft
- (5) Other: None

GOOSE COVE RESERVOIR DAMS AND DIKES

f. Reservoir Surface (acres)

- (1) Normal pool: 60 at El 75.0
- (2) Flood control pool: N/A
- (3) Spillway crest: 60 at El 75.0
- (4) Test flood pool: 65.0
- (5) Top of dam: 65

g. Dams and Dikes

	<u>North Dam</u>	<u>Northwest Dike</u>	<u>South Dam</u>	<u>Southwest Dike</u>
1) Type	Earthfill			
2) Length:	318 ft.	472 ft.	551 ft.	524 ft.
3) Height:	34.7 ft.	45.2 ft.	17.1 ft.	9.3 ft.
4) Top width:	20 ft.	20 ft.	20 ft.	20 ft.
5) Side slopes:	2:1 (horizontal to vertical)			
6) Zoning:	impervious upstream blanket over pervious random fill			
7) Impervious core:	None			
8) Cutoff:	10 ft.	10 ft.	5 ft.	none
9) Grout curtain:	None			
10) Other:	North Dam: concrete collars around outlet conduit underneath dam. Northwest Dike: toe drain and discharge trench at downstream toe. South Dam: riprap at base, concrete collars around outlet conduit underneath dam.			

i. Spillway

Goose Cove North Dam:

- (1) Type: concrete drop inlet with four weirs

GOOSE COVE RESERVOIR DAMS AND DIKES

	<u>North Dam</u>	<u>Northwest Dike</u>	<u>South Dam</u>	<u>Southwest Dike</u>
(1) Streambed at toe of embankment:	45.5	35	62.9	71.0
(2) Bottom of cutoff:	40	30	55	N/A
(3) Maximum tailwater:	N/A	N/A	N/A	N/A
(4) Normal pool:	75.0	75.0	75.0	75.0
(5) Full flood control pool:	N/A	N/A	N/A	N/A
(6) Spillway crest:	75.0	N/A	78.0	N/A
(7) Design surcharge (Original design):	77.25	77.25	77.25	77.25
(8) Top of embankment:	80.2	80.2	80.0	80.3
(9) Test flood surcharge:	80.15	80.15	80.15	80.15

d. Reservoir (Length in feet)

- (1) Normal pool: 3,680 at El 75.0
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 3,680 at El 75.0
- (4) Top of dam: 3,740
- (5) Test flood pool: 3,740

e. Storage (acre-feet)

- (1) Normal Pool: 825 at El 75.0
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 825 at El 75.0
- (4) Top of dam: 1138
- (5) Test flood pool: 1147

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove South Dam:

Discharge from Goose Cove South Dam flows over the spillway and into a stone-lined discharge channel. Water also discharges from the outlet into the pipeline to Babson Reservoir.

- (1) Outlet: Size - 20 in. dia. Invert El 55.0
Discharge Capacity - controlled at Babson Reservoir.
- (2) Maximum known reservoir level: June 1979, El 78.
- (3) Ungated spillway capacity at top of dam: 182 cfs at El 80.0.
- (4) Ungated spillway capacity at test flood elevation: 210 cfs at El 80.15.
- (5) Gated spillway capacity at normal pool elevation: N/A.
- (6) Gated spillway capacity at test flood elevation: N/A.

The combined capacities of the spillway at South Dam and drop inlet spillway at North Dam are:

- (1) Total spillway capacity at test flood elevation: 404 cfs at El 80.15.
- (2) Total project discharge at top of dam: 376 cfs at El 80.0.
- (3) Total project discharge at test flood elevation: 416 cfs at El 80.15.

- c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 80.0 on the top of the embankment at the South Dam. This elevation was estimated from a United States Geological Survey (U.S.G.S.) topographic map.

GOOSE COVE RESERVOIR DAMS AND DIKES

A July 16, 1971 inspection report for the dams and dikes, which is the only reported inspection since construction, indicates that the dams and dikes were in excellent condition. Repairs have been made such as replacement of the sluice gate stems (1975) and an enclosure on the South Dam gatehouse (1975).

1. Normal Operating Procedures. Personnel from the Department of Public Works reportedly visit the reservoir once a day. At that time, they inspect the site and, if necessary, operate the gates at the South Dam gatehouse. The low-level outlet at the North Dam was last operated in the summer of 1979 to check its operation.

1.3 Pertinent Data

- a. Drainage Area. The drainage area is approximately 422 acres (0.66 square mile) and consists of gently rolling land (see Figure D-1 in Appendix D). About 12.1 percent of the drainage area is ponds and swamps. In general, the undeveloped portions of the drainage area consist totally of woodland. Moderate residential development occurs to the west and north of the reservoir. Dense residential development occurs to the southwest of the reservoir.

- b. Discharge

Goose Cove North Dam:

Discharge from Goose Cove North Dam flows over four weirs in the drop inlet and into a concrete conduit. Water also discharges from the low-level outlet into the same conduit.

- (1) Outlet: Size - 24-in. dia. Invert El 50.0.
Discharge Capacity - 74 cfs at El 75.0.
- (2) Maximum known reservoir elevation: June 1979, El 78.
- (3) Ungated spillway capacity at top of dam: 194 cfs at El 80.0.
- (4) Ungated spillway capacity at test flood elevation: 194 cfs at El 80.15.
- (5) Gated spillway capacity at normal pool elevation: N/A.
- (6) Gated spillway capacity at test flood elevation: N/A.

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove South Dam:

There are 15 houses located along the channel 600 feet downstream of the dam. The foundations of these structures are 5 to 8 feet above the stream channel. There are 2 new houses directly adjacent to the right abutment of the dam (see Flood Impact Area shown on Location Map). An assumed failure of the dam would result in a flood wave 8.2 feet high up to 600 feet downstream of the dam, as compared to a height of 2.5 feet prior to failure. More than a few lives could be lost and a significant amount of property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.

Goose Cove Southwest Dike:

There are 3 houses located along the channel 300 feet downstream of the dike (see Flood Impact Area shown on the Location Map). The foundations of these structures are approximately level with the floor of the channel. An assumed failure of the dike would result in a flood wave 4.8 feet high 400 feet downstream of the dike, compared to no flow prior to failure. More than a few lives could be lost and a moderate amount of property damage could occur. Accordingly, the dike has been placed in the "high" hazard category.

- e. Ownership. The dams and dikes are owned by the city of Gloucester, City Hall, Dale Avenue, Gloucester, Massachusetts 01930. Mr. James McNulty, Director of Public Works (telephone 617-283-5940) granted permission to enter the property and inspect the dams and dikes.
- f. Operator. The reservoir facility is operated by personnel from the Gloucester Department of Public Works.
- g. Purpose of the Dam. The water in Goose Cove Reservoir is used for water supply by the city of Gloucester. At the time of inspection, there was very little water in the reservoir due to the prolonged dry-weather conditions.
- h. Design and Construction. Construction of the Goose Cove Dams and Dikes was completed in 1963. Drawings dated February, 1963 and prepared by Metcalf & Eddy, Inc. are available. The drawings show that the dams and dikes were constructed essentially as they appear today, except that the gatehouse at the South Dam was not enclosed.

GOOSE COVE RESERVOIR DAMS AND DIKES

- c. Size Classification. For a dam to be classified as intermediate it must have a height between 40 and 100 feet or a maximum storage capacity between 1,000 and 50,000 acre-feet. Goose Cove North Dam has been classified as "intermediate" on the basis of its storage capacity of 1,138 acre-feet. Goose Cove Northwest Dike has been classified as "intermediate" on the basis of its height of 45.2 feet and its storage capacity of 1,138 acre-feet.

For a dam to be classified as small, it must have a height between 25 and 40 feet or a maximum storage capacity between 50 and 1,000 acre-feet. Goose Cove South Dam has been classified as "small" on the basis of its height of 17.1 feet and its storage capacity of 940 acre-feet. Goose Cove Southwest Dike has been classified as "small" on the basis of its height of 9.3 feet and its storage capacity of 599 acre-feet.

- d. Hazard Classification

Goose Cove North Dam:

There are 12 houses located along the stream starting 500 feet downstream of the dam (see Flood Impact Area shown on the Location Map). The foundations of the structures are approximately four feet above the floor of the stream. An assumed failure of the dam would result in a flood wave 14.5 feet high up to 800 feet downstream of the dam, as compared to a height of 2.5 feet prior to failure. More than a few lives could be lost and a significant amount of property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.

Goose Cove Northwest Dike:

There are 6 houses located along the channel 625 feet downstream of the dike (see Flood Impact Area shown on the Location Map). The foundations of these structures are from 2 to 10 feet above the floor of the channel. An assumed failure of the dike would result in a flood wave 13.5 feet high up to 830 feet downstream of the dam, compared to no flow prior to failure. More than a few lives could be lost and a significant amount of property damage could occur. Accordingly, the dike has been placed in the "high" hazard category.

GOOSE COVE RESERVOIR DAMS AND DIKES

The spillway, located near the left abutment of the dam is a 20-foot long, broad-crested concrete weir. The approach channel consists of the riprap on the upstream face of the dam. There are no provisions for stoplogs or flashboards. The crest of the spillway is at El 78.0.

The discharge channel below the spillway is 25-feet wide. The channel has no side walls. The floor of the channel is lined with riprap and covered with small stones. It slopes at thirty-three percent.

Two intakes and the low-level outlet are in a gatehouse located 285 feet from the right abutment of the dam. The upper intake is a 20-inch diameter opening protected by a trash rack and located on the upstream face of the gatehouse. The invert of the intake is at El 65.0.

The lower intake is a 24-inch prestressed concrete cylinder pipe encased in concrete. The upstream end of the pipe is located 80 feet into the reservoir and has an invert at El 55.7. The downstream end of the pipe joins the right side of the gatehouse. Flow through the intake is controlled by a sluice gate operated manually from a floor stand in the gatehouse.

The low-level outlet is a 20-inch prestressed concrete cylinder pipe in an 8-inch concrete encasement and is located on the downstream face of the gatehouse. The invert of the outlet is at El 55.0. Flow through the intakes and the low-level outlet is controlled by sluice gates operated manually from floor stands in the gatehouse. The low-level outlet connects to a 20-inch cast iron pipe 97 feet downstream of the gatehouse. This pipe conducts water to the Babson Reservoir.

Access to the gatehouse from the top of the dam is by a service bridge constructed with two steel I-beams and concrete decking. The bridge is supported by a concrete abutment on the dam and by the gatehouse.

Goose Cove Southwest Dike:

The Goose Cove Southwest Dike is a 524-foot long earth-fill embankment with a maximum height of 9.3 feet (see Plan of Dam and Sections in Appendix B and photographs in Appendix C). The top of the dike is 20 feet wide and is at El 80.3. The upstream face is a 2:1 slope covered with riprap. The downstream face is a 2:1 slope covered with grass. Available drawings indicate that the dike is a zoned embankment with an impervious blanket on the upstream face.

GOOSE COVE RESERVOIR DAMS AND DIKES

structure. The downstream end of the outlet has an invert at El 48.50 and is covered with a screen. Discharge flows into a stilling basin and downstream in a natural channel.

The concrete stilling basin has two 6.7-foot high wing-walls, each with an 8-inch vitrified clay toe drain. The floor of the basin is at El 45.5 and has concrete impact blocks.

Goose Cove Northwest Dike:

Goose Cove Northwest Dike is a 472-foot long earthfill dike with a maximum height of 45.2 feet (see Plan of Dam and Sections in Appendix B and Photographs in Appendix C). The top of the dike is 20 feet wide and is at El 80.2. The upstream face is a 2:1 slope covered with riprap. The downstream face is a 2:1 slope covered with grass. There is a 10-foot layer of riprap at the downstream toe. Available drawings indicate that the dike is a zoned embankment with an impervious blanket on the upstream face and extending upstream of the dike. The drawings also show that the dike is founded on hard granite with a cutoff trench up to ten feet below the base of the dike.

There is no spillway or low level outlet. There are two 8-inch vitrified clay toe drains which joint near the center of the downstream toe at a toe drain. This drain discharges into a narrow downstream trench.

Goose Cove South Dam:

Goose Cove South Dam is a 551-foot long earthfill embankment with a maximum height of 17.1 feet (see Plan of Dam and Sections in Appendix B and photographs in Appendix C). The top of the dam is 20 feet wide and varies from El 80.2 to 80.0. There is a 51.5 degree bend in the embankment at a distance of 360 feet from the right abutment. The upstream face is a 2:1 slope covered with riprap. The downstream face is a 2:1 slope covered with grass. There is riprap at the toe of the dam opposite the gatehouse. A 12-inch reinforced concrete toe drain extends from this riprap to the far side of the access road. Available drawings indicate that the dam is a zoned embankment with an impervious blanket on the upstream face. The drawings also show that the dam has a cutoff trench up to five feet below the base of the dam.

GOOSE COVE RESERVOIR DAMS AND DIKES

	Latitude (north)	Longitude (west)
North Dam	42 deg. 38.9 min.	70 deg. 39.8 min.
Northwest Dike	42 deg. 38.8 min.	70 deg. 39.9 min.
South Dam	42 deg. 38.3 min.	70 deg. 39.9 min.
Southwest Dike	42 deg. 38.6 min.	70 deg. 40.2 min.

b. Description of Dam and Appurtenances

Goose Cove North Dam:

Goose Cove North Dam is a 318-foot long, earthfill dam with a maximum height of 34.7 feet (see Plan of Dam and sections in Appendix B and Photographs in Appendix C). The top of the dam is 20 feet wide and is at El 80.2. The upstream face is a 2:1 slope covered with riprap. The downstream face is a 2:1 slope covered with grass. Available drawings indicate that the dam is a zoned embankment with an impervious blanket on the upstream face and extending upstream of the dam. The drawings also show that the dam is founded on hard granite with a cutoff trench up to ten feet below the base of the dam.

A concrete drop inlet upstream of the dam contains the spillway and low-level outlet. Access to the structure is by boat. The spillway consists of four 4-foot by 5-foot openings on the sides of the structure. The four openings are each covered by a trash rack and together provide about 20 feet of over-flow weir at El 75.0.

The low-level outlet is a 24-inch diameter opening on the upstream face of the inlet structure. The opening has an invert at El 50.0 and is controlled by a 24-inch by 24-inch sluice gate. The gate is operated manually from a floor stand located on top of the inlet structure.

Discharge from the spillway and low-level outlet flows into a 36-inch prestressed concrete pipe located on the downstream face of the inlet structure. Flow into the pipe is not controlled. The upstream invert is at El 50.0. The pipe is 147 feet long and slopes at 0.5 percent from the inlet structure to the centerline of the dam and then slopes at 1.67 percent to the outlet

GOOSE COVE RESERVOIR DAMS AND DIKES

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
GOOSE COVE RESERVOIR DAMS AND DIKES
SECTION 1
PROJECT INFORMATION

1.1 General

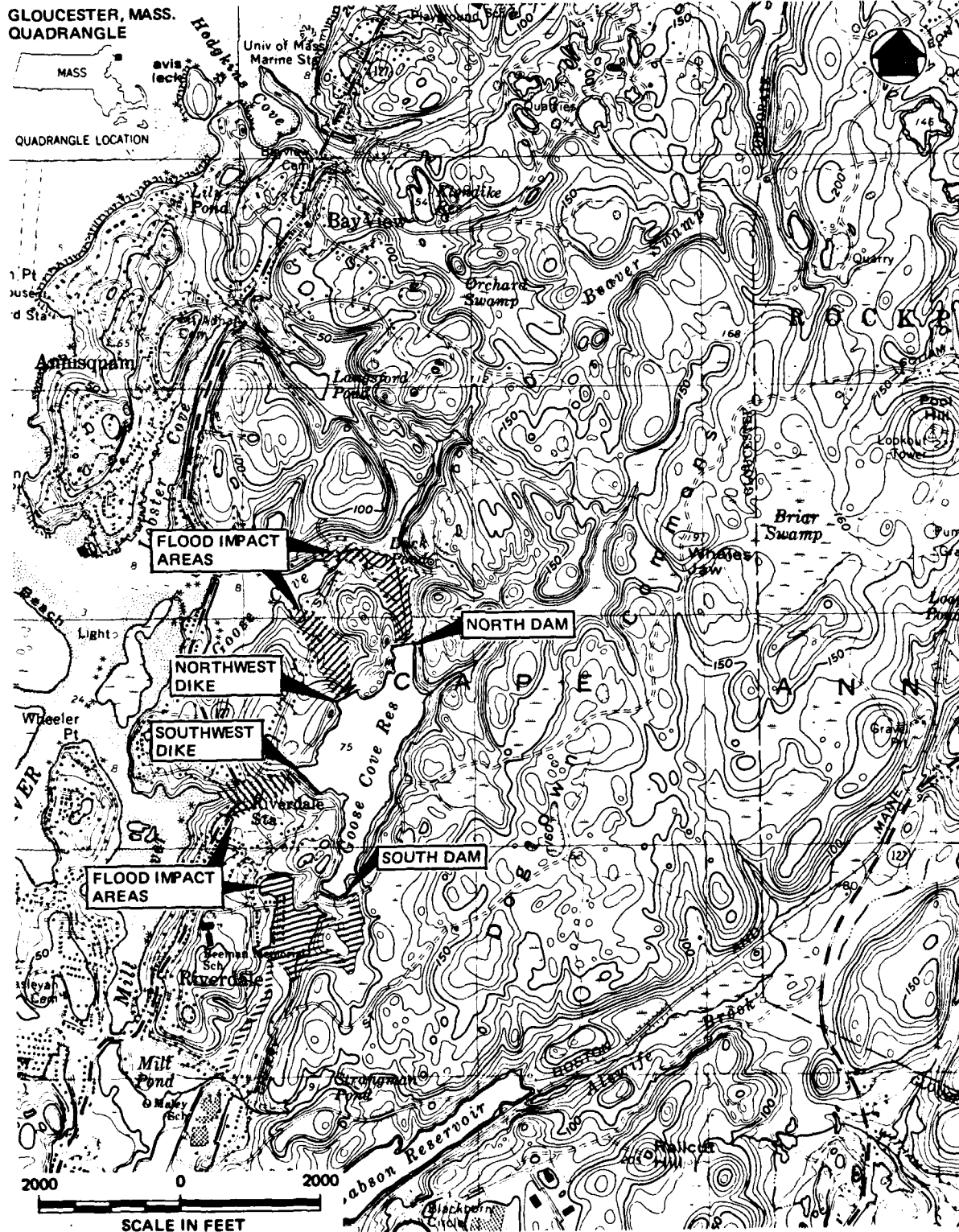
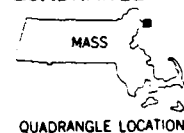
- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-80-C-0054, dated April 18, 1980, has been assigned by the Corps of Engineers for this work.
- b. Purpose
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to quickly initiate effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location. The dams and dikes are located in the city of Gloucester, Essex County, Massachusetts and in the Annisquam River Basin (see Location Map). The coordinates of the Goose Cove Reservoir Dams and Dikes are as follows:

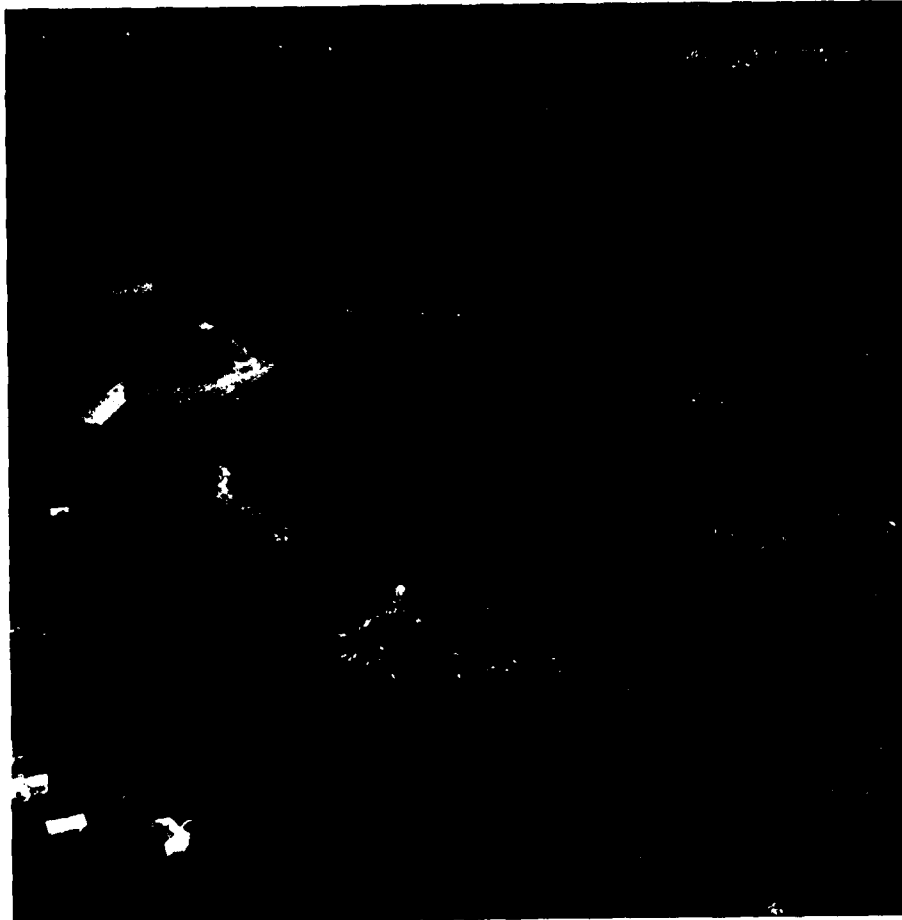
GOOSE COVE RESERVOIR DAMS AND DIKES

**GLOUCESTER, MASS.
QUADRANGLE**

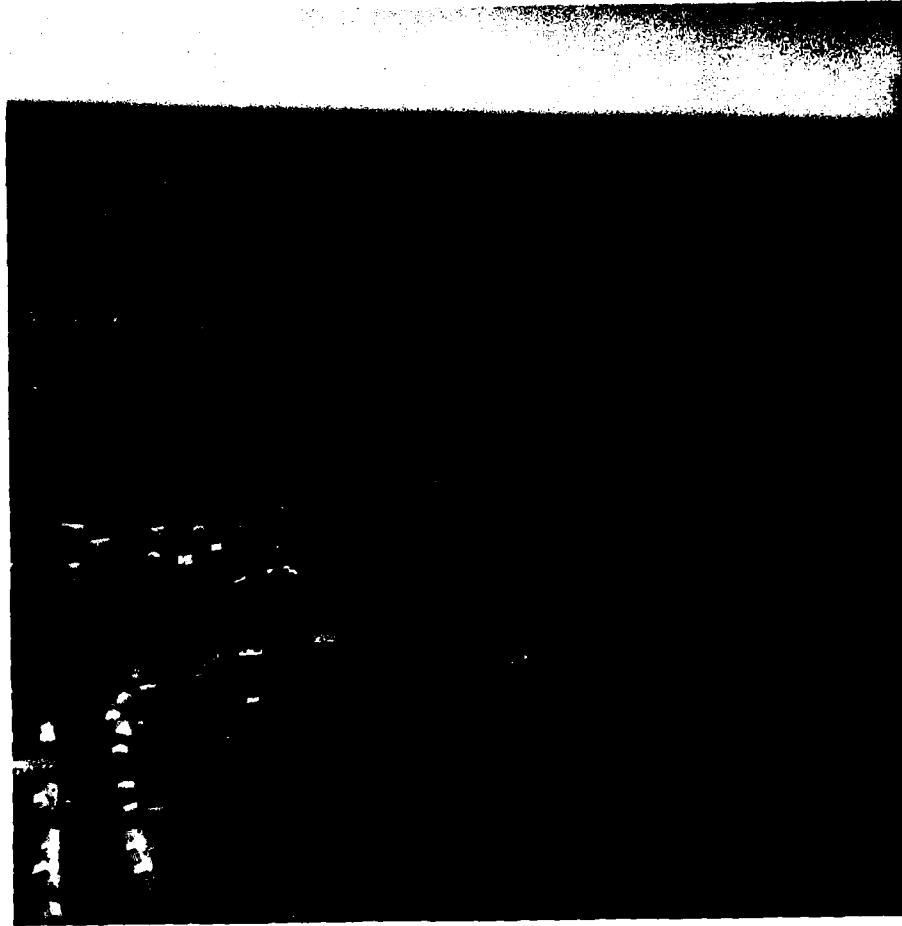


LOCATION MAP - GOOSE COVE RESERVOIR DAMS AND DIKES

OVERVIEW
GOOSE COVE RESERVOIR SOUTHWEST DIKE
GLOUCESTER, MASSACHUSETTS



OVERVIEW
GOOSE COVE RESERVOIR SOUTH DAM
GLOUCESTER, MASSACHUSETTS



Goose Cove South Dam:

- (1) Invert El: upper intake - 65.0
lower intake - 55.6
low-level outlet - 55.0
- (2) Size: upper intake - 30 inch dia. orifice
lower intake - 24 inch dia. concrete conduit
low-level outlet - 20 inch dia. concrete conduit
- (3) Description: intakes and outlet in the gatehouse on upstream slope of dam
- (4) Control mechanism: sluice gates operated from floor stands on the deck of the gatehouse
- (5) Other: The outlet conduit connects to a pipeline to Babson Reservoir.

SECTION 2

ENGINEERING DATA

- 2.1 General. The engineering data available for this Phase I inspection include drawings and computations dated 1963 prepared by Metcalf & Eddy, Inc. (see Figures B-6 through B-11). A copy of a previous inspection report dated 1971 and prepared by the Commonwealth of Massachusetts is included in Appendix B. This is the only reported inspection since construction.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways; the Massachusetts Department of Public Works; and the Essex County Engineers Office. In addition, we acknowledge the assistance of Messrs. James McNulty, Robert Martinack, and John Marchant of the city of Gloucester, Department of Public Works, who provided information on the history and operation of the dam.

- 2.2 Construction Records. As-built drawings are available for the dam and appurtenances and selected drawings have been included in Appendix B (see B-6 through B-11).

- 2.3 Operating Records. The operating records are weekly readings of the water elevation in the reservoir.

2.4 Evaluation

- a. Availability. The design engineering data for the dams and dikes is available.
- b. Adequacy. The evaluation of the adequacy of the dams and dikes is based on a review of the design computations, record drawings, visual inspection, past performance history, and engineering judgment.
- c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the two dams and two dikes at Goose Cove Reservoir was performed on November 21, 1980. A copy of the inspection checklist is included in Appendix A. A previous inspection was conducted by the Massachusetts Department of Public Works in 1971. A copy of this report is included in Appendix B. Selected photographs taken during our Visual Inspection are included in Appendix C.

b. Dam.

Goose Cove North Dam:

The dam is an earthfill embankment with a drop inlet spillway (see Photo No. 1). There was no evidence of seepage, as the water level in the reservoir was near the toe of the dam.

Several ruts from vehicular traffic were visible on the downstream face of the dam. There were also minor ruts on the top of the dam, which serves as the access road.

There are 24 inch to 36 inch pieces of riprap along the lower quarter of the downstream face of the dam. On the upper 10 feet of the upstream face, along the entire length of the crest, some small pieces of riprap are dislodged, leaving holes. The large riprap on the upstream face of the embankment is intact (see Photo No. 2).

Brush and trees from 1 to 4 inches in diameter are growing on the downstream slope and small brush and saplings are growing on the upper ten feet of the upstream slope of the dam (see Photos No. 1 and 2).

Goose Cove Northwest Dike:

The dike is an earthfill structure. Although the water level in the reservoir was at El 60.66, which is near the toe of the dike, clear water was discharging at about 10 gpm from the toe drain, which is at El 35, at the center of the downstream toe of the dike (see Photo No. 9).

There were footpaths down the right side and center of the embankment. A large rut, reportedly cut by a bulldozer, is located near the center of the downstream slope. The rut is about three to four feet wide and is filled with organic material (see Photo No. 6).

The top of the dike is not paved, but is used as an access road. Tire ruts six inches deep are worn into the top of the dike (see Photo No. 7).

Riprap on the upstream face and along the downstream toe of the embankment appears to be intact. Brush is growing on the upper ten feet of the upstream slope (see Photo No. 8). A very heavy growth of brush and trees from one to six inches in diameter is on the downstream face of the dike (see Photo No. 9).

Goose Cove South Dam:

The dam is an earthfill embankment with a spillway, gatehouse and service bridge (see Photos No. 10, 14, and 15). There was no evidence of seepage, as the water level in the reservoir was below the toe of the dam.

Moderate erosion resulting from vehicles and motorcycles was noted on the top and downstream face of the dam. Tire ruts five inches deep are located along the top of the dam near the right abutment. Tire ruts on the downstream face of the dam (see Photo No. 11) are about 1-foot deep and extend along the face of the dam.

Some small pieces of riprap are dislodged from the upstream face of the embankment. These holes have been filled in with two-inch stone (see Photo No. 12). The large pieces of riprap on the upstream face are intact.

Stone riprap is visible along the toe of the downstream slope opposite the gatehouse. This appears to be the toe drain at the downstream toe of the dam (see Figure B-9). The riprap is intact. A twelve-inch reinforced concrete drain pipe runs from the riprap at the toe of the dam to the far side of the roadway (see Photo No. 13). The downstream end is clear.

Brush and small trees are growing on the downstream face and the upstream face of the dam (see Photos No. 10 and 14).

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove Southwest Dike:

The dike is an earthfill embankment. There was no evidence of seepage, as the water level in the reservoir was below the toe of the dike.

There were tire tracks and ruts from vehicles and dirt bikes on the top, downstream face, and downstream toe of the dike. There was some erosion and loss of grass cover in the tire paths (see Photo Nos. 18 and 19). There were two small pools of water between the access road and the toe of the dike and adjacent to the center of the dike.

Small pieces of riprap are dislodged from portions of the upstream face of the embankment. There is some rubble where these pieces are missing. Small brush is growing in the upper three feet of the embankment (see Photo No. 20).

c. Appurtenant Structures

Goose Cove North Dam:

A concrete drop inlet contains the spillway and outlet. The exterior of the shaft was in good condition. There was no spalling or efflorescence and only minor staining below the high water mark (see Photo No. 3). On each side of the structure, there is a spillway opening covered with a trash rack. The trash racks appeared to be in good condition. A floor stand for the sluice gate on the outlet is located on the top of the inlet. The gate operator is not kept at the site. Access to the operator is by boat using a ladder on one side of the inlet structure.

The interior of the shaft was in good condition. There are three small horizontal cracks with efflorescence in the shaft. They are located 1.5 feet, 4 feet, and 8 feet up from the bottom of the sluice gate. There is some exposed aggregate caused by cavitation or erosion.

There is a sump, five feet square and two feet deep, at the base of the shaft. Some debris, including small sticks and stones, has accumulated in the sump and there is minor debris at the top.

On one of the interior walls of the outlet there is a four inch butterfly valve with a cracked gasket and a rusty stem. This valve is located 4.7 feet above the invert of the sluice gate.

GOOSE COVE RESERVOIR DAMS AND DIKES

The downstream outlet conduit is in good condition. There is minor cracking in the pipe, though most of it is patched. Approximately 75 feet in from the downstream end there is a three-quarter inch gap at a joint in the conduit with no apparent seepage or efflorescence.

The intrusion screen for the discharge end of the conduit was bent out of place and the corner bolts were missing. Slight seepage from the concrete beneath the conduit was visible. The seepage consists of wet areas stained with rust and is flowing at less than one gpm (see Photo No. 4).

Goose Cove South Dam:

The spillway is a broad-crested, trapezoidal weir without flashboards or stoplogs. The concrete on the crest of the spillway was in fair condition. Minor cracking and some spalling exists at the corners of the weir. The crest of the spillway was clear of debris. The approach channel was in fair condition. Some dislodged pieces of riprap and a minor growth of brush were observed on the floor of the approach channel (see Photo No. 14).

The service bridge is generally in good condition. There is minor rust on the steel I beams. The wood on the underside of the deck is in good condition, as is the concrete on the deck. The railings on the bridge have been removed (see Photo No. 15).

The outlet and gatehouse were visible during the inspection due to the low water level in the reservoir. The gatehouse is in good condition, with only slight spalling and efflorescence (see Photo Nos. 15 and 16). There is slight staining below the high water mark.

The upper section of the gatehouse is constructed of concrete blocks with a slab roof. There are two intakes and one outlet in the gatehouse. The gates are operated through holes in the floor of the upper section of the gatehouse. The gate operators are kept at the Department of Public Works. All three gates were open and reportedly operable. The sluice gate for the upper intake has minor rusting. The concrete inside the gatehouse was in fair condition below the high water mark. There is some minor spalling and efflorescence. The ladder rungs and anchor bolts are in good condition.

The outlet conduit, which connects to a pipeline to Babson Reservoir, is not visible.

GOOSE COVE RESERVOIR DAMS AND DIKES

- d. Reservoir Area. The reservoir area is moderately developed. The city of Gloucester is located to the south of the reservoir. Residential development exists on the north, west and southwest sides of the reservoir. Most of the land is wooded with gently rolling slopes. There is a high potential that future development will occur adjacent to the reservoir area, as evidenced by the new construction near the South Dam.
- e. Downstream Channel.

Goose Cove North Dam:

The outlet discharges into a concrete outlet structure. The wingwalls are in good condition. There is an 8-inch drain hole on each wall. Clear water was discharging at about 8 gpm and 0.5 gpm from the right and left drain holes, respectively (see Photo No. 5). The floor of the outlet structure is coated with rust. Concrete piers in the floor serve as energy dissipator (see Photos No. 4).

Discharge from the outlet flows in a downstream channel for a distance of about 3,700 feet before entering the Annisquam River. The sides of the channel are earth slopes. The channel is covered with brush and rock. There is a slight accumulation of debris in the floor of the channel.

Trees, approximately ten inches in diameter, are overhanging the sides of the channel.

Goose Cove Northwest Dike:

There is a small trench which carries discharge from the toe drains in the embankment. The sides of the trench are earth slopes. The floor of the trench is covered with grass and leaves (see Photo No. 9). Trees and brush are overhanging the trench. Discharge would flow about 2,700 feet downstream to the Annisquam River.

Goose Cove South Dam:

The spillway discharges into the downstream channel which is a stone apron on the downstream face of the dam. The floor of the channel is a layer of riprap covered with soil, silt, and small rocks. Small brush is growing in the floor of the channel (see Photo No. 17). Beyond the access road, water discharges into a swampy area. From there, water would flow about 5,500 feet before reaching the Annisquam River.

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove Southwest Dike:

There is no spillway or toe drains at this location.

3.2 Evaluation. The visual inspection indicates that the dams and dikes at Goose Cove Reservoir are in fair condition. The stated deficiencies which must be corrected to assure the continued performance of the dams and dikes and the measures to improve these conditions are outlined in Section 7. The following conditions could affect the long-term performance of the dam:

- a. erosion on the top and downstream face of the dams and dikes
- b. a growth of brush and trees on the downstream face and upper portion of the upstream face of the dams and dikes
- c. an accumulation of debris in the downstream channel at the North Dam and Northwest Dike
- d. dislodged riprap on the upstream face at the North Dam
- e. a damaged intrusion screen on the outlet conduit of the North Dam.

The reservoir was drawn down at the time of inspection. The dams and dikes should be reinspected when the reservoir is at or near the spillway crest (El 75). The purpose would be to identify any signs of seepage through the embankments.

SECTION 4

OPERATING AND MAINTENANCE PROCEDURES

4.1 Operating Procedures

- a. General. The standard operating procedure is reportedly to visit the reservoir site daily and to operate the gates at the South Dam, as required by the City's water demand. Once a week a reading is taken of the reservoir elevation.
- b. Warning System. There is no warning system in effect at any of the dams or dikes.

4.2 Maintenance Procedures

- a. General. The dams and dikes are generally adequately maintained, although localized erosion and growth of vegetation is occurring at all the sites. The Department of Public Works is responsible for maintenance of the facilities. Periodic inspections by personnel from the Department of Public Works have been conducted in the past. Typical maintenance procedures have included backfilling eroded areas on the embankments and clearing debris from the spillways and outlets.
- b. Operating Facilities. Maintenance of the operating facilities consists of operating the gates at the South Dam. There is no standard maintenance procedure for the outlet at the North Dam, although it is reportedly checked periodically.

- 4.3 Evaluation. There are no regular programs of maintenance or technical inspections for the dams or dikes. There are also no plans for surveillance of the dams or dikes during periods of heavy rainfall, or for warning people in downstream areas in the event of an emergency at the dams and dikes. The lack of standard operating and maintenance procedures is undesirable, considering that the dams and dikes are in the "high" hazard category. These programs should be implemented as recommended in Section 7.3.

SECTION 5

EVALUATION OF HYDRAULIC/ HYDROLOGIC FEATURES

- 5.1 General. The Goose Cove Reservoir Dams and Dikes have a drainage area of 0.66 square miles of which 12.1 percent is ponds and swamps (see Figure D-1, Drainage Area Map in Appendix D). The land is gently rolling and undeveloped.

Goose Cove Reservoir has a surface area of approximately 65 acres, and a maximum storage capacity of 1138 acre-feet at El 80.0.

The low-level outlet at the North Dam can discharge a flow of 74 cfs when the reservoir is at El 75.0 which is the crest of the spillway. At this reservoir elevation and with no additional inflow, the outlet can lower the reservoir by 1 foot in about 9 hours.

- 5.2 Design Data. The spillways at the north and south dams were designed on the Kinnison-Colby rare flood. The peak inflow was 310 cfs with a high water elevation of 77.25.
- 5.3 Experience Data. There is no record of overtopping of the present dams or dikes which were constructed in 1963. Available records indicate a maximum reservoir level of approximately El 78 occurring in the summer of 1979.
- 5.4 Test Flood Analysis. At Goose Cove Reservoir, the North Dam and Northwest Dike have been classified in the "intermediate" size and "high" hazard categories. The South Dam and Southwest Dike have been classified in the "small" size and "high" hazard categories. The full PMF was selected to evaluate the capacities of the spillways.

The PMF rate for the Goose Cove Reservoir watershed was calculated to be 1175 cfs per square mile of drainage area. This calculation is based on the average slope of 1.29 percent in the drainage area, the pond-plus-swamp area to drainage area ratio of 12.1 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). For this analysis, the peak flow rate was determined to be slightly above the guide curve for flat and coastal topography.

GOOSE COVE RESERVOIR DAMS AND DIKES

Assuming a pool level at El 75.0 at the start of test flood routing, assuming that all outlets are closed, and applying the full PMF rate to the 0.66 square mile drainage area results in a peak test flood inflow of 774 cfs. By adjusting the test flood inflow for surcharge storage, the peak test flood outflow was calculated to be 416 cfs (631 cfs per square mile). The reservoir level would rise to El 80.15.

Hydraulic analyses indicate that the combined spillways can discharge 376 cfs, with 194 cfs discharging over the North Dam drop inlet and 182 cfs discharging over the South Dam emergency spillway. This is 90 percent of the test flood outflow with the reservoir at El 80.0, which is the low point on the top of the South Dam.

During the test flood, the low point on the South Dam would be overtopped by 0.15 feet. About 404 cfs would discharge over the spillways, with 194 cfs discharging through the North Dam drop inlet and 210 cfs over the South Dam spillway. About 12 cfs would discharge over the top of the South Dam. Where critical flow occurs, the water would be 0.09 feet deep at a velocity of 1.67 feet per second (fps).

Considering the 1/2 PMF, hydraulic analyses indicate that the spillways can discharge 376 cfs, or 201 percent of the one-half PMF outflow with the pond at El 80.0, which is the low point on the top of the South Dam.

5.5 Dam Failures Analysis.

Goose Cove North Dam:

The peak discharge rate due to failure of the dam was calculated to be 24,900 cfs with the pond at El 80.0. This calculation is based on a maximum head of 24.0 feet and an assumed 126-foot wide breach occurring in the center of the embankment. Failure of the dam would produce a downstream flood wave 14.5 feet deep as compared to a channel flow 2.5 feet deep prior to failure.

There are 12 houses located along the channel starting 500 feet downstream of the dam. The foundations of these structures are approximately 4 feet above the floor of the stream. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dam could result in a flood wave that would rise above the foundation level of these houses by approximately 10 feet, resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

GOOSE COVE RESERVOIR DAMS AND DIKES

Goose Cove Northwest Dike:

The peak discharge rate due to failure of the dike was calculated to be 40,890 cfs with the pond at El 80.0. This calculation is based on a maximum head of 25.5 feet and an assumed 189-foot wide breach occurring in the center of the embankment. Failure of the dike would produce a downstream flood wave 13.5 feet deep as compared to no flow prior to failure.

There are 6 houses located along the channel 625 feet downstream of the dike. The foundations of these structures are approximately 2 to 10 feet above the floor of the channel. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dike could result in a flood wave that would rise above the foundation level of some of these houses by about 10 feet, resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dike has been placed in the "high" hazard category.

Goose Cove South Dam:

The peak discharge rate due to failure of the dam was calculated to be 5,700 cfs with the pond at El 80.0. This calculation is based on a maximum head of 12.5 feet and an assumed 77-foot wide breach occurring between the gatehouse and the spillway. Failure of the dam would produce a downstream flood wave 8.2 feet deep as compared to channel flow 2.5 feet deep prior to failure.

There are 15 houses located along the channel 600 feet downstream of the dam. The foundations of these structures are 5 to 8 feet above the stream channel. There are 2 houses directly adjacent to the right abutment of the dam. Due to the configuration of the channel, some attenuation of the flood flow is expected, especially near the downstream houses. An assumed failure of the dam could result in a flood wave that would rise about 3 feet above the foundation level of these houses, resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

Goose Cove Southwest Dike:

The peak discharge rate due to failure of the dike was calculated to be 7980 cfs with the pond at El 80.0. This calculation is based on a maximum head of 8.0 feet and an assumed 210-foot wide breach occurring in the center of the

GOOSE COVE RESERVOIR DAMS AND DIKES

embankment. Failure of the dike would produce a downstream flood wave 4.8 feet deep as compared to no flow prior to failure.

There are 3 houses located along the channel 300 feet downstream of the dike. The foundations of these structures are approximately level with the floor of the channel. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dike could result in a flood wave that would rise approximately 4 feet above the foundation level of these houses resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dike has been placed in the "high" hazard category.

SECTION 6

STRUCTURAL STABILITY

- 1 Visual Observations. The evaluation of the structural stability of the Goose Cove Reservoir Dams and Dikes is based on a review of previous inspection reports, a review of available drawings, and the visual inspection conducted on November 21, 1980.

Goose Cove North Dam:

As discussed in Section 3, Visual Inspection, the dam is in fair condition. Areas of erosion were observed on the downstream face and crest of the dam. A growth of trees and vegetation exists on the downstream face and upper portions of the upstream face of the dam.

Goose Cove Northwest Dike:

As discussed in Section 3, Visual Inspection, the dam is in fair condition. Areas of erosion and tire ruts were observed on the downstream face and crest of the dike. A growth of trees and brush exists on the slopes of the dike. A rut cut by a bulldozer on the downstream slope was filled in with organic material.

Goose Cove South Dam:

As discussed in Section 3, Visual Inspection, the dam is in fair condition. Areas of erosion and tire ruts were observed on the downstream face and on the top of the dam. Some brush and vegetation exists on the upstream and downstream faces of the dam.

Goose Cove Southwest Dike:

As discussed in Section 3, Visual Inspection, the dike is in fair condition. Areas of erosion and tire ruts were observed on the top and downstream face of the dike. Some brush was growing on the upper portions of the upstream face of the dike.

- 2 Design and Construction Data. Construction of the Goose Cove Reservoir Dams and Dikes was completed in 1963. Computations for design of the dam, spillway, and outlet by Metcalf & Eddy, Inc. were reviewed. Drawings dated February 1963 prepared by Metcalf and Eddy, Inc. show the as-built construction of the dam (see Figures B-6 through B-11).

GOOSE COVE RESERVOIR DAMS AND DIKES

PERIODIC INSPECTION CHECK LIST

PROJECT NORTHWEST DIKE

DATE November 21, 1980

PROJECT FEATURE Dike

NAME Marie Nowak

DISCIPLINE Geotechnical

NAME Mike Larson

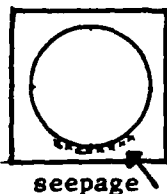
AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	
Crest Elevation	80.2
Current Pool Elevation	60.6
Maximum Impoundment to Date	Unknown
Surface Cracks	6" tire track ruts on unpaved crest of dam.
Pavement Condition	Surface not paved, but used as roadway. Fair condition.
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Good, straight
Horizontal Alignment	Good, level
Condition at Abutment and at Concrete Structures	Exposed rock and boulders at both abutment. Stone (riprap) path down right abutment.
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes	Footpaths down right side and center of embankment. A large rut (due to bulldoze) down the embankment has been filled with organic material (3-4')
Sloughing or Erosion of Slopes or Abutments	None visible
Rock Slope Protection - Riprap Failures	Thick growth of brush, trees and grass on downstream embankment. Riprap at D/S toe across length of dam. Trees from one to six inches in diameter.
Unusual Movement or Cracking at or near Toes	None visible
Unusual Embankment or Downstream Seepage	None visible
Piping or Boils	None visible
Foundation Drainage Features	Drainage at downstream toe, near center of embankment. Flow is clear, 10 gpm is in drainage trench going downstream.
Toe Drains	None visible
Instrumentation System	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT NORTH DAM DATE November 21, 1980
 PROJECT FEATURE Outlet Works NAME Marie Nowak
 DISCIPLINE Hydraulics NAME Michael Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	Fair to good condition
Rust or Staining on Concrete	None visible
Spalling	None visible
Erosion or Cavitation	Yes, some exposed aggregate
Cracking*	
Alignment of Monoliths	N/A
Alignment of Joints	3/4" gap (joint not butted) with no apparent seepage or efflorescence
Numbering of Monoliths	N/A

1.



Trash rack covering conduit was bent out of place.
 Corner bolts missing.
 Seepage from below conduit is shiny layer over rust.
 Flow less than 1 gpm.

2. INSIDE OF CONDUIT

- Minor cracking in pipe, most of it is patched. Some visible strips of wood.

At Sump:

4" butterfly valve with cracked gasket and rusty stem.

The stem to slide gate connection is in good condition.

There are three horizontal cracks with efflorescence at 1½', 4' & 8' up from the bottom of the slide gate invert. There is some exposed aggregate caused by cavitation or erosion.

PROJECT NORTH DAM, (Cont.)

DATE November 21, 1980

DROP INLET SPILLWAY

Opening on 4 sides of tower, and gated on all sides.

Valve on top of structure. Valve operator is missing.

Access to the spillway by boat only.

PERIODIC INSPECTION CHECK LIST

PROJECT NORTH DAM

DATE November 21, 1980

PROJECT FEATURE Outlet Works

NAME Marie Nowak

DISCIPLINE Structural

NAME Michael Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	10 ladder rungs up one side of tower, some bent.
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None visible
Visible Reinforcing	None
Rusting or Staining of Concrete	Minor staining below high water mark.
Any Seepage or Efflorescence	None visible
Joint Alignment	Good
Unusual Seepage or Leaks in Gate	N/A
Cracks	None visible
Rusting or Corrosion of Steel	None visible
b. Mechanical and Electrical	N/A
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST

PROJECT NORTH DAM

DATE November 21, 1980

PROJECT FEATURE Spillway, Outlet

NAME Marie Nowak

DISCIPLINE Hydraulics

NAME Michael Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Fair to good
Rust or Staining	Rust on bottom of channel.
Spalling	Slight
Erosion or Cavitation	None
Visible Reinforcing	None visible
Any Seepage or Efflorescence	None visible
Condition at Joints	N/A
Drain Holes	8" right wingwall, 8 gpm Clear discharge 8" left wingwall, 1/2 gpm
Channel	Logs, rocks (energy dissipators)
Loose Rock or Trees Over- hanging Channel	Trees, 10" diameter, overhanging the downstream channel.
Condition of Discharge Channel	Fair, some debris in channel.

PROJECT NORTH DAM (Cont.)

DATE Nov. 21, 1980

UPSTREAM FACE

Large riprap is in good condition on upstream face of dam. Smaller pieces are missing, leaving holes on face of dam. Small filler rocks are visible at the toe (water surface).

Trees are growing on the upper 10' of slope, from one to four inches in diameter.

There are a few large holes where the riprap is missing.

PERIODIC INSPECTION CHECK LIST

PROJECT NORTH DAM DATE Nov. 21, 1980
 PROJECT FEATURE Dam NAME Nicholas D'Agostino
 DISCIPLINE Geotechnical NAME Marie Nowak

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	80.2
Current Pool Elevation	60.6
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible
Pavement Condition	Gravel, minor vehicular rutting
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Good, straight
Horizontal Alignment	Good, level
Condition at Abutment and at Concrete Structures	Rt. abutment, good Lt. abutment, good
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	Yes, ruts visible in several places on downstream slope.
Sloughing or Erosion of Slopes or Abutments	None visible
Rock Slope Protection - Riprap Failures	24"-36" riprap with openings of up to 1 foot where chinked stone moved.
Unusual Movement or Cracking at or near Toes	None visible. 24"-36" diameter riprap along lower 1/4 of downstream slope.
Unusual Embankment or Downstream Seepage	Minor seepage along outlet end of pipe at invert.
Piping or Boils	None visible
Foundation Drainage Features	See below
Toe Drains	8"vc toe drains, left drain-minor seepage Rt. drain-8 to 10 gpm. located along wing walls of outlet. Discharge is clear
Instrumentation System	None

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT NORTH DAM, NORTHWEST DIKE
SOUTH DAM, SOUTHWEST DIKE

DATE Nov. 21, 1980

TIME 10:30 A.M.

Abbreviations;

D/S = Downstream

U/S = Upstream

N/A = Not Applicable

WEATHER Cloudy 40°

W.S. ELEV. 60.6 U.S. Dry DN.S.

BENCHMARK: Assumed embankment crest
Elevation 80.0 (NGVD) at South
Dam, opposite Gatehouse.

PARTY:

1.	Marie Nowak	Metcalf & Eddy, Inc.	Hydraulics/Hydrology
2.	Mike Larson	Metcalf & Eddy, Inc.	Geotechnical
3.	Nick D'Agostino	Metcalf & Eddy, Inc.	Geotechnical
4.	Frank Gordon	Metcalf & Eddy, Inc.	Geotechnical
5.	Bill Checchi	Metcalf & Eddy, Inc.	Geotechnical
6.	Scott Nagel	Metcalf & Eddy, Inc.	Geotechnical
7.	Ed Greco	Metcalf & Eddy, Inc.	Geotechnical
8.			
9.			
10.			

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	Larson/Nowak	
2.	Spillway (Inlet)	Larson/Nowak	
3.	Outlet	Larson/Nowak	
4.	Conduit	Checchi/Nowak	
5.			
6.			

APPENDIX A
PERIODIC INSPECTION CHECKLIST

GOOSE COVE RESERVOIR DAMS AND DIKES

- (1) Clear trees, brush and roots by hand from each embankment, and to a distance of 25 feet from the toe of the dam or dike.
- (2) To prevent continued erosion, fill in, topsoil and seed eroded areas on the upstream and downstream face of the earth embankment portions of the dams and dikes. Excavate the organic material from the rut in the Northwest Dike and refill with proper material.
- (3) Replace dislodged riprap on the upstream face of each embankment.
- (4) Place additional earthfill in the ruts on the crest and downstream face of each embankment. Consider paving the crests of all dams as part of the road around the reservoir.
- (5) Remove all brush, trees, debris and loose stone in the floor of the outlet discharge channel.
- (6) Remove logs and debris caught on the spillway weir at the South Dam.
- (7) Remove debris from the downstream end of the outlet pipe and repair intrusion screen at North Dam.
- (8) Institute a definite plan for surveillance of each dam, dike and spillway during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dams and dikes.
- (9) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dams, dikes and appurtenances and be supplemented by additional inspections during and after severe storms. The valves at the North Dam should be exercised on an annual basis. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir to prevent clogging of the spillway.
- (10) Institute a program of annual technical inspections of these dams and dikes.

7.4 Alternatives.

There are no practical alternatives to the above recommendations.

GOOSE COVE RESERVOIR DAMS AND DIKES

and maintenance, the dike is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dike: erosion and ruts on the top and downstream face of the dike; and some brush on the upstream face.

The peak test flood (full PMF) outflow for Goose Cove Reservoir is estimated to be 416 cfs with the pond at El 80.15. The test flood would only overtop the low point on the South Dam. Hydraulic analyses indicate that the spillways at the North and South Dams can discharge a combined flow of 376 cfs or 90 percent of the test flood outflow before the South Dam is overtopped.

- b. Adequacy. The evaluation of the Goose Cove Reservoir Dams and Dikes is based on a review of the available data, the visual inspection, past performance and engineering judgement.
- c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

7.2 Recommendations.

Goose Cove North Dam, Northwest Dike, South Dam, Southwest Dike:

It is recommended that the Owner employ a qualified registered engineer to:

- a. Evaluate the seismic stability of the dams and dikes.
- b. Investigate the cause of seepage at the outlet of the North Dam and the drain of the Northwest Dike to recommend procedure to remedy situations if necessary.
- c. Examine the dams and dikes for seepage during a period when the reservoir is nearly full.

The Owner should implement the recommendations of the Engineer.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures.

Goose Cove North Dam, Northwest Dike, South Dam, Southwest Dike:

It is recommended that the Owner accomplish the following at each site:

GOOSE COVE RESERVOIR DAMS AND DIKES

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition.

Goose Cove North Dam:

As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dam: erosion on the top and downstream face of the dam; dislodged riprap from the upstream face; a heavy growth of brush and trees on the downstream face and on the upper portions of the upstream face; damaged intrusion screen on outlet conduit; and an accumulation of debris in the downstream channel.

Goose Cove Northwest Dike:

As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dike is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dike: erosion on the top and downstream face of the dike; a very heavy growth of brush and trees on the downstream face and on the upper portion of the upstream face; and an accumulation of debris in the channel downstream of the toe drain.

Goose Cove South Dam:

As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dam: erosion on the top and downstream face of the dam and some brush on the downstream face and on the upper portions of the upstream face of the dam.

Goose Cove Southwest Dike:

As a result of the visual inspection, the review of available data, and limited information on operation

GOOSE COVE RESERVOIR DAMS AND DIKES

- 6.3 Post-Construction Changes. Since the original construction of the dams and dikes, the following changes have been made. The superstructure of the gatehouse at the South Dam was constructed in 1975. The stems of the sluice gate at the South Dam were replaced in 1975.
- 6.4 Seismic Stability. The dams and dikes are located in Seismic Zone No. 3. Phase I Guidelines recommend, as a minimum, that suitable analysis made by conventional equivalent static load methods should be on record for dams in Zone No. 3. As far as can be determined, no such analysis has been made.

Goose Cove North Dam:

The as-built drawings show that the dam is a zoned earthfill embankment founded on hard granite. An impervious blanket 5 feet thick is located on the upstream face of the embankment. A 3-foot thick impervious blanket extends upstream of the embankment. The remaining earthfill is shown as pervious random fill. A cutoff trench extends up to 10 feet below the upstream toe of the dam. There are 6 concrete collars around the outlet pipe to prevent piping. A drainage trench extends as much as 6 feet below the downstream toe of the dam. The side slopes of the embankment are 2:1 both upstream and downstream.

Goose Cove Northwest Dike:

The as-built drawings show that the dike is a zoned earthfill embankment founded on hard granite. An impervious blanket 5 feet thick is located on the upstream slope of the dike. A 3-foot thick impervious blanket extends upstream of the embankment. The remaining earthfill is shown as pervious random fill. A cutoff trench extends up to ten feet below the upstream toe of the dam. A drainage trench at the downstream toe extends up to six feet below the base of the dam. The side slopes of the embankment are 2:1 both upstream and downstream.

Goose Cove South Dam:

The as-built drawings show that the dam is a zoned earthfill embankment. An impervious blanket 5 feet thick is located on the upstream face of the embankment. A cutoff trench extends up to 5 feet below the upstream toe of the dam. The remaining earthfill is shown as pervious random fill. There are concrete collars in a section through the intake works. A rockfill toe drain is constructed at the base of the downstream slope. The side slopes of the embankment are 2:1 both upstream and downstream.

Goose Cove Southwest Dike:

The as-built drawings show that the dike is a zoned earthfill embankment. An impervious blanket 5 feet thick is located on the upstream face of the embankment. The remaining earthfill is shown as pervious random fill. There is no cutoff trench. The side slopes of the embankment are 2:1 both upstream and downstream.

Specifications for construction of the dam are available. These include details on the types of earth materials, riprap, and concrete used in construction.

GOOSE COVE RESERVOIR DAMS AND DIKES

PROJECT NORTHWEST DIKE, Cont.

DATE November 21, 1980

Upstream Face

Riprap in good condition with some new fill at the top. Brush is growing in the top 10 feet of slope. No visible slumping or sloughing.

Downstream Face (cont.)

The drainage trench proceeds straight out from the toe of the dam. It has rock near the walls of the channel and a thick growth of grass and brush throughout.

PERIODIC INSPECTION CHECK LIST

PROJECT SOUTH DAM DATE November 21, 1980
 PROJECT FEATURE Dam NAME Nicholas D'Agostino
 DISCIPLINE Geotechnical NAME Marie Nowak

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	80.0
Current Pool Elevation	60.6
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible
Pavement Condition	Gravel and grass 5" deep tire ruts near right embankment
Movement or Settlement of Crest	Slight depression on surface
Lateral Movement	None visible
Vertical Alignment	Good, level
Horizontal Alignment	Good, dog leg in dam
Condition at Abutment and at Concrete Structures	Right-good, buried rock Left-good, isolated rock outcrop
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes	Rutting from motorcycles, vehicles on downstream slope to right of spillway, to right of angle point and gatehouse.
Sloughing or Erosion of Slopes or Abutments	None. Grass needs mowing. Several 3' high pines growing on slope.
Rock Slope Protection - Riprap Failures	24" riprap granite blocks-good condition Generally with 2" trap rock in windows between blocks. Few small pieces missing.
Unusual Movement or Cracking at or near Toes	None visible
Unusual Embankment or Downstream Seepage	None visible
Piping or Boils	None visible
Foundation Drainage Features	Riprap visible at area along downstream slope opposite gatehouse
Toe Drains	12" RC drain pipe from riprap at toe 2+90 3+30, downstream end clear
Instrumentation System	N/A

PROJECT SOUTH DAM, (Cont.)

DATE November 21, 1980

UPSTREAM FACE

The large pieces of riprap are in good condition. A few smaller pieces are missing. Small rocks have been placed to fill in these holes.

There are many small bushes on the upstream slope.

BEYOND RIGHT ABUTMENT

Several houses are located just beyond the right abutment. These houses are above the present water level, but below the crest of the dam. Two of the houses are constructed, two are under construction and more will reportedly be built.

BEYOND LEFT ABUTMENT

Inlet - 3 foot diameter concrete pipe. The depth of water is about 1".

Intake - Wing walls are in fair condition. Trash bars are missing. Some stones in the pipe. Holes in riprap between the intake and overflow.

Diversion - Concrete is fair to good. There is a narrow vertical crack at one corner, and a diagonal crack at the other. There are a lot of bushes and trees throughout the entire area.

PERIODIC INSPECTION CHECK LIST

PROJECT SOUTH DAM

DATE November 21, 1980

PROJECT FEATURE Outlet Works

NAME Marie Nowak

DISCIPLINE Structural

NAME Mike Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	Generally in good condition
Bearings	Embankment & Gatehouse
Anchor Bolts	None, cast into gatehouse structure
Bridge Seat	See above
Longitudinal Members	Some rust on steel I Beams
Under Side of Deck	Wood, in good condition
Secondary Bracing	N/A
Deck	Concrete, in good condition
Drainage System	N/A
Railings	Missing, have been torn off
Expansion Joints	N/A
Paint	N/A
b. Abutment and Piers	Gatehouse is abutment
General Condition of Concrete	See outlet works
Alignment of Abutment	See outlet works
Approach to Bridge	From dam crest
Condition of Seat and Backwall	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT SOUTH DAM

DATE November 21, 1980

PROJECT FEATURE Outlet Works

NAME Marie Nowak

DISCIPLINE Structural

NAME Mike Larson

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	Bottom is concrete, gatehouse is cinder block. Both appear to be in good condition, both inside and out.
a. Concrete and Structural	
General Condition	See above
Condition of Joints	Good
Spalling	Only slight, at one corner.
Visible Reinforcing	None
Rusting or Staining of Concrete	None visible above high water line. Slight staining below high water line.
Any Seepage or Efflorescence	Slight efflorescence on outside
Joint Alignment	Good
Unusual Seepage or Leaks in Gate	Reservoir below outlet
Cracks	None
Rusting or Corrosion of Steel	None
b. Mechanical and Electrical	No electrical service at gatehouse.
Air Vents	Hole in ceiling
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	None
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System in Gate Chamber	None

PROJECT SOUTH DAM, Cont.

DATE November 21, 1980

Inside Gatehouse

Two inlets and one outlet carry water to and from Babson reservoir. (Pumps at Babson) All three were open and reported operable. The valve operators are kept at the town garage.

The valves have been recently operated.

The screens are cleaned once a year, though there were no screens visible at the South gatehouse.

Gatehouse was built over the valve controls. Gates are operable from top of gatehouse through holes in the ceiling. (concrete slab roof.)

Entire gatehouse and intake visible due to low water level.

Inside the shaft: Ladder rungs are on both sides and in very good condition. Anchor bolts are in good condition. The slide gate below the valve is in good condition, but rusted. Below high water mark, concrete is in fair to good condition. There is minor spalling with some efflorescence.

PERIODIC INSPECTION CHECK LIST

PROJECT SOUTH DAM DATE November 21, 1980
 PROJECT FEATURE Spillway NAME Marie Nowak
 DISCIPLINE Hydraulics NAME Mike Larson

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	Generally in good condition.
a. Approach Channel	
General Condition	Fair
Loose Rock Overhanging Channel	A few pieces of riprap are missing.
Trees Overhanging Channel	None
Floor of Approach Channel	Minor brush growth in between riprap
b. Weir and Training Walls	
General Condition of Concrete	Fair condition with some minor cracks.
Rust or Staining	None visible
Spalling	Some, at the corners.
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	There appears to be a layer of riprap covered with soil, silt, & small rocks.
General Condition	Fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Small brush growing in silt.
Other Obstructions	None

PERIODIC INSPECTION CHECK LIST

PROJECT SOUTHWEST DIKE

DATE November 21, 1980

PROJECT FEATURE Dike

NAME Marie Nowak

DISCIPLINE Geotechnical

NAME Mike Larson

AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	
Crest Elevation	80.3
Current Pool Elevation	60.6
Maximum Impoundment to Date	Unknown
Surface Cracks	None visible. Five small ruts near left abutment about 10" wide, 10" deep, 2 Ft. long made by fires.
Pavement Condition	Fair, small ponds of water on surface.
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Right-mostly earth with some large rocks Left-joins with a paved access road
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes	Several tire tracks and ruts from vehicles and dirt bikes.
Sloughing or Erosion of Slopes or Abutments	Erosion and loss of grass cover on dike slope at tire paths. More tire ruts at base of dike.
Rock Slope Protection - Riprap Failures	Riprap intact.
Unusual Movement or Cracking at or near Toes	None visible
Unusual Embankment or Downstream Seepage	Ponding between access road and toe of dike, probably a low spot filled with snow melt.
Piping or Boils	None visible
Foundation Drainage Features	12" diameter drain from one side of access road to the other
Toe Drains	None
Instrumentation System	N/A

PROJECT SOUTHWEST DIKE, cont.

DATE November 21, 1980

Dike Embankment - Upstream Face

Riprap is in fair to good condition. There is some small rubble fill at the top where the smaller pieces of riprap have been dislodged.

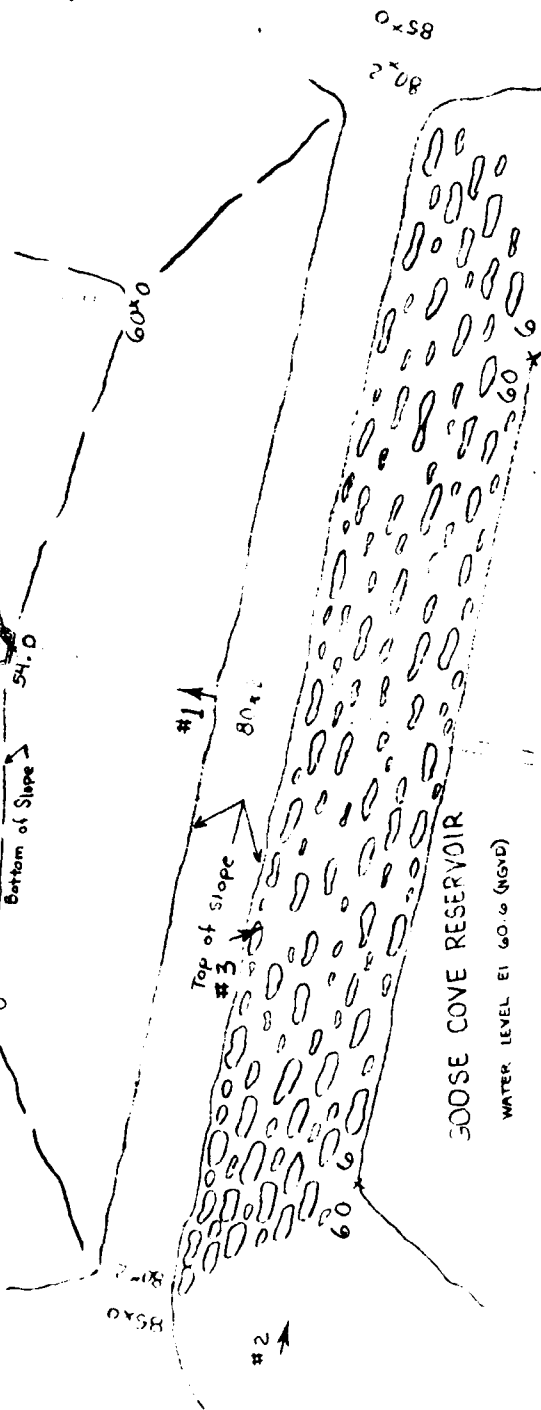
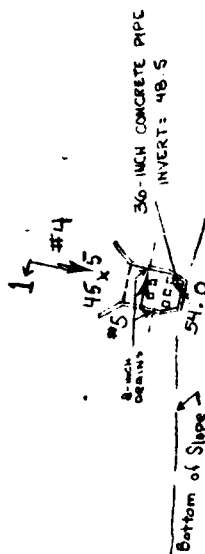
Small brush is growing in the top 2 to 3 feet of embankment.

No sloughing or slumping on upstream face. Some of the smaller, dislodged pieces of riprap are at the toe of the upstream face.

Wetlands/swampy area to the west of left embankment, at a higher elevation than the dike.

APPENDIX B
PLANS OF DAMS AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1 through B-5, Plans and Sections of Dams and Dikes, based on field inspecitn of 21 November 1980	B-1
Figure B-6 through B-11, Plans and Detailes of Dams and Dikes, Metcalf and Eddy Record drawings of 1963	B-6
Previous Inspection Reports	
Dated July 1971 by Massachusetts Department of Public Works	B-12



GOOSE COVE RESERVOIR

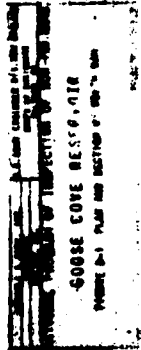
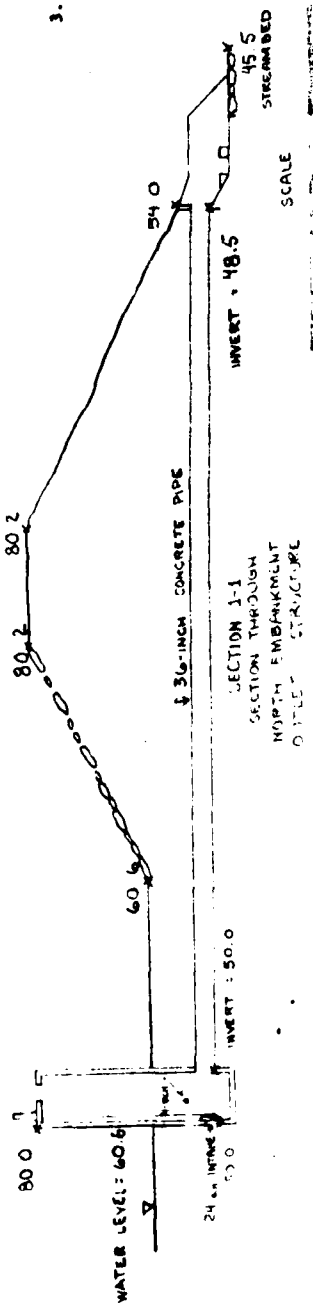
WATER LEVEL EI 60.6 (NGVD)

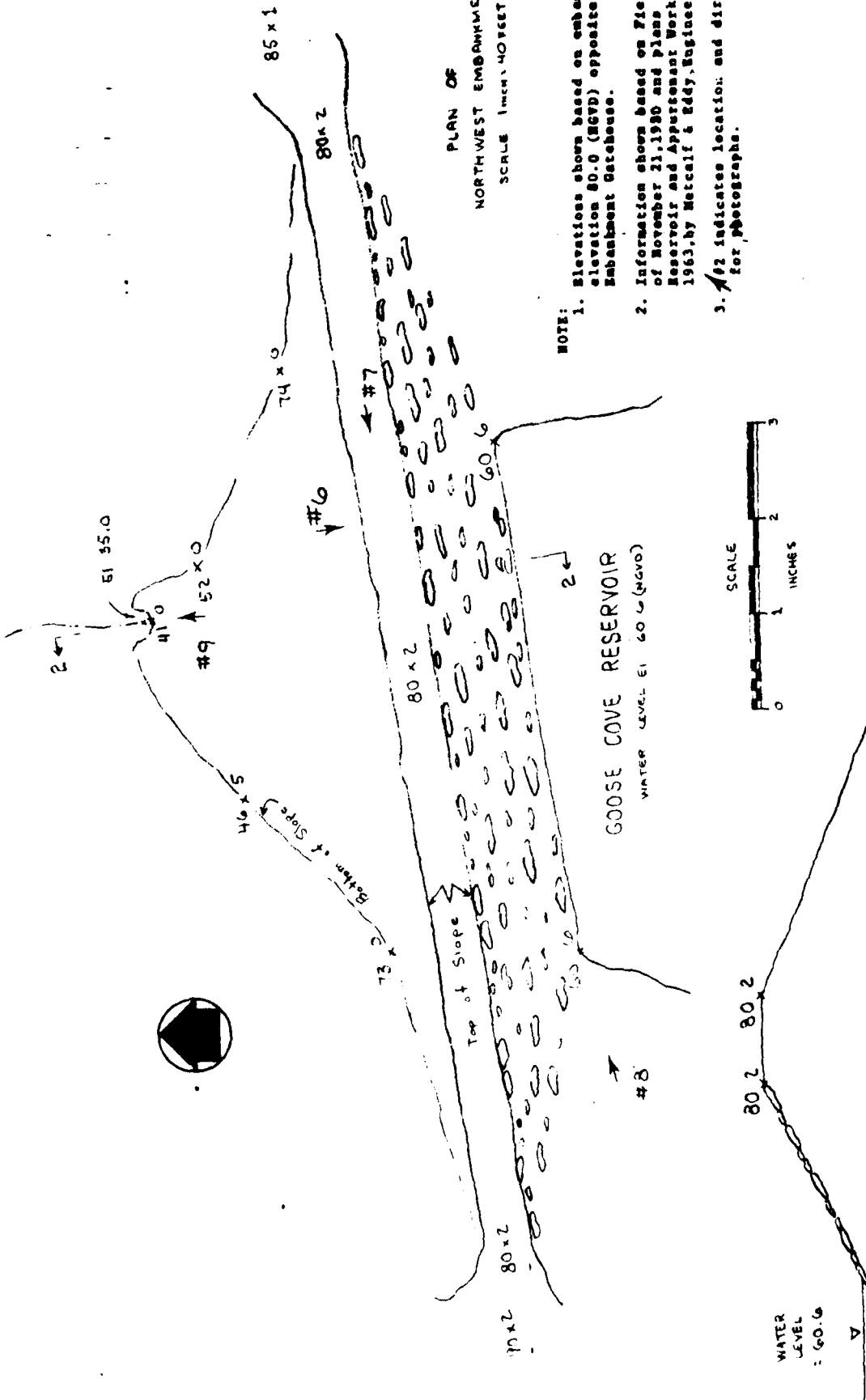
CONCRETE INTAKE STRUCTURE

NOTE:

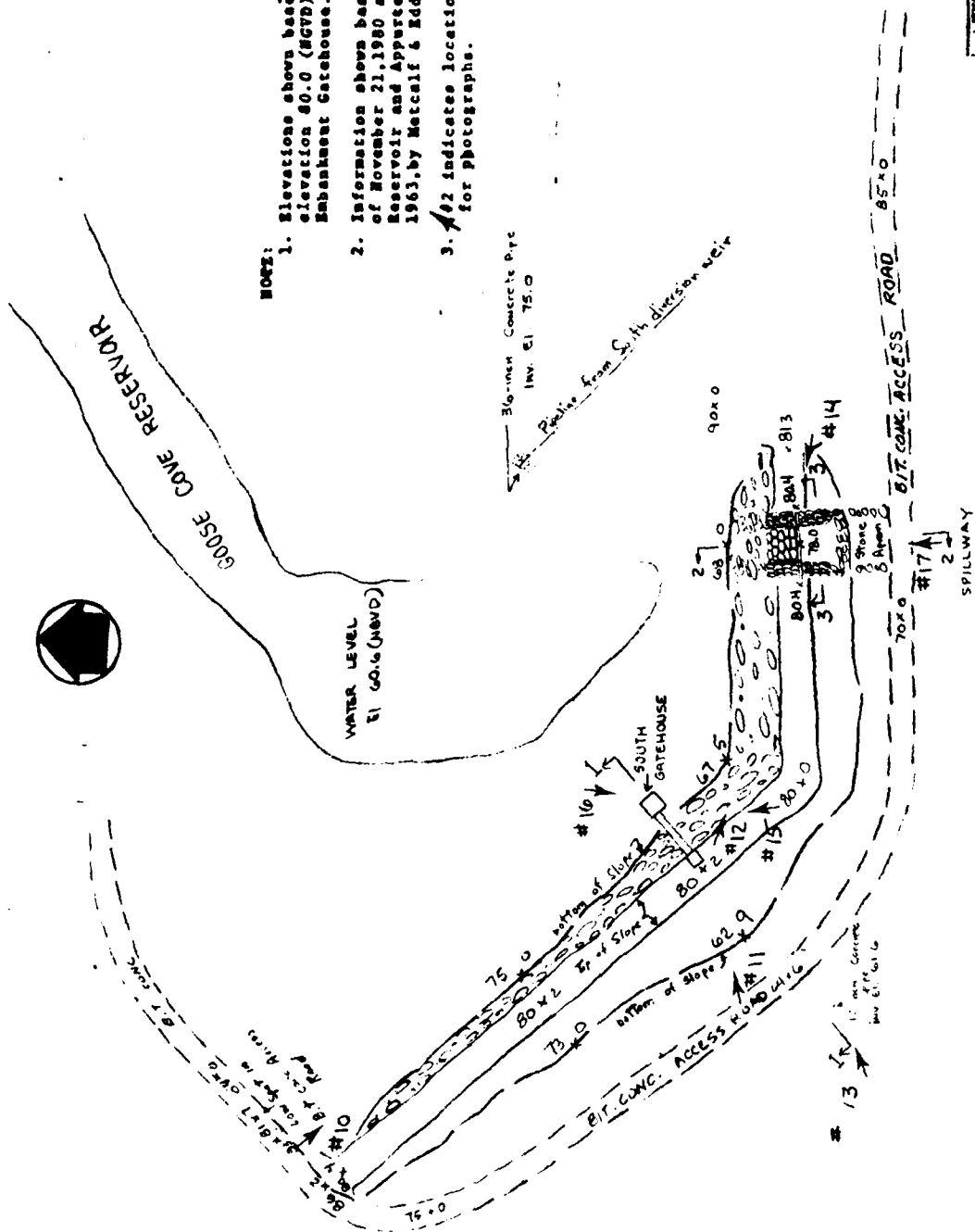
1. Elevations shown based on embankment crest elevation 80.0 (MSVD) opposite South Embankment Catchment.
2. Information shown based on Field Inspection of November 21, 1980 and plans of "Goose Cove Reservoir and Appurtenant Work", February 1983, by Metcalf & Eddy, Engineers, Boston.
3. #12 indicates location and direction of view for photographs.

PLAN OF NORTH EMBANKMENT
SCALE 1" = 30' HORIZ





GOOSE COVE RESERVOIR
PLAN AND SECTION OF EMBANKMENT
FIGURE 2-1



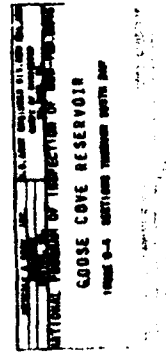
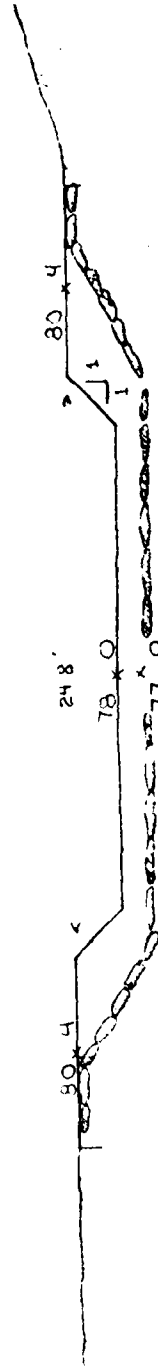
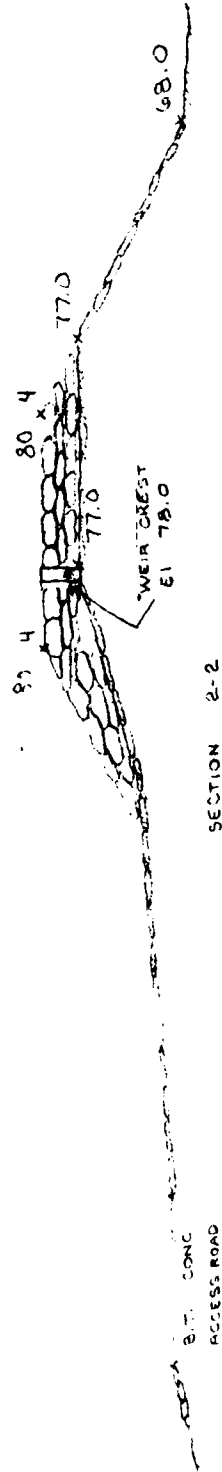
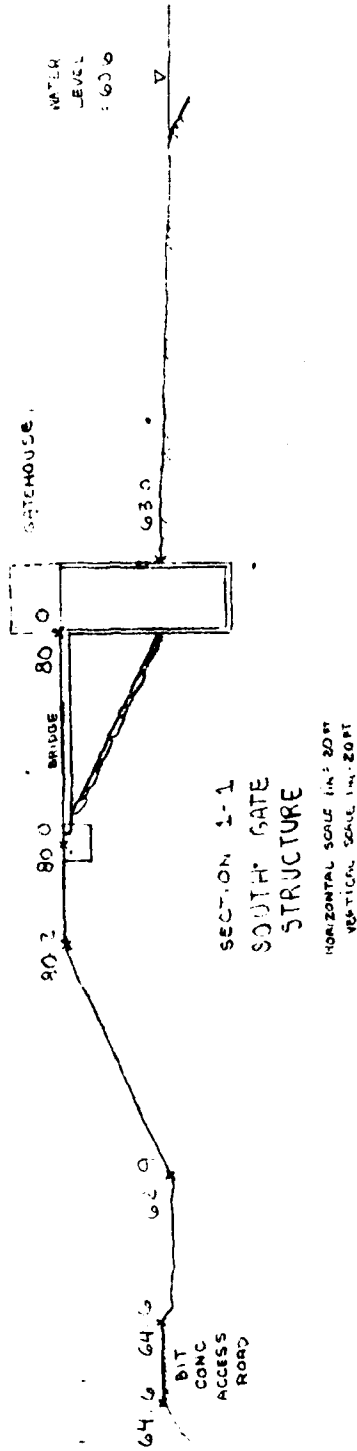
NOTES:

1. Elevations shown based on embankment crest elevation 80.0 (MGVD) opposite South Embankment Gatehouse.
2. Information shown based on Field Inspection of November 21, 1980 and plans of "Goose Cove Reservoir and Appurtenant Work", February 1963, by Metcalf & Eddy, Engineers, Boston.
3. #12 indicates location and direction of view for photographs.

GOOSE COVE RESERVOIR
FIGURE 8-3 PLAN OF EMBANKMENT

PROPERTY OF THE U.S. ARMY

WALLA WALLA





NO. 1 DOWNSTREAM SLOPE OF NORTH DAM



NO. 2 UPSTREAM SLOPE OF NORTH DAM

APPENDIX C

PHOTOGRAPHS

re: Location and direction of photographs shown on
Figure B-1, B-2, B-3, and B-5 in Appendix B.

GOOSE COVE RESERVOIR DAMS AND DIKES

D 22

GLoucester
5-5-107-21

L.E. WILKINSON

7/16/71

1

ON GOOSE COVE RESERVOIR (SOUTHWESTERLY END) BEGIN ON WASHINGTON
AT GEE AVE. TAKE GEE AVE. NORTHEASTERLY 0.40 MI. TO ACCE:
TO DAM. TAKE ACCESS ROAD NORTHERLY 600 FT. TO DAM.

CITY OF GLOUCESTER

WATER SUPPLY

EARTH WITH HEAVY STONE RIPRAP WATER SIDE

GATES OR OUTLETS

20.00 ± FT.

80.00

500.0 ± FT.

20.0 ± FT.

NONE - THIS DAM FUNCTIONS AS
SIMPLE DIKE.

DAM IN GENERALLY EXCELLENT CONDITION

GOOSE COVE RESERVOIR DAMS AND DIKES

D 22 —

GLOUCESTER
5-5-107-21

L.E. WILKINSON

7/16/71

1

ON GOOSE COVE RESERVOIR (SOUTHWESTERLY END) BEGIN ON WASHINGTON
AT GEE AVE. TAKE GEE AVE. NORTHEASTERLY 0.40 MI. TO ACCE:
TO DAM. TAKE ACCESS ROAD NORTHERLY 600 FT. TO DAM.

CITY OF GLOUCESTER

WATER SUPPLY

EARTH WITH HEAVY STONE RIPRAP WATER SIDE

GATES OR OUTLETS

20.00 ± FT.

80.00

500.0 ± FT.

20.0 ± FT.

NONE - THIS DAM FUNCTIONS AS
SIMPLE DIKE.

DAM IN GENERALLY EXCELLENT CONDITION

ON SOUTH END OF GOOSE COVE RESERVOIR. BEGIN ON WASHINGTON
T. AT GEE AVE. TAKE GEE AVE. NORTHEASTERLY 0.40 MI. TO ACCESS
TO DAM. TAKE ACCESS ROAD SOUTHERLY 0.25 MI. TO DAM.

CITY OF GLOUCESTER

WATER SUPPLY

EARTH WITH HEAVY STONE RIP RAP ON WATER SIDE
HOUSE WITH THREE VALVES CONNECTED TO DAM BY STEEL
& CONC. SLAB RUNWAY. 20" PIPELINE TO BABSON RESERVOIR

25.0 ± FT.

80.00

SED ON U.S. & G. SURVEY DATUM

600.0 ± FT

20.0 ± FT.

~~WATER~~ - WATER LEVEL 7'-3" BELOW

RET FLOOR OF GATE HOUSE. WATER LEVEL 4'-6" BELOW CREST
LL OF CONC. SPILLWAY. 20'-3" WIDE X 30" DEEP HEAVY STON
ING BOTH SIDES OF WALL ACROSS SPILLWAY CHANNEL. EAST E
D 19.

DAM IN GENERALLY EXCELLENT CONDITION

5.5-107-18

GOOSE COVE RESERVOIR DAMS AND DIKES

GLOUCESTER
5-5-107-20

L.E. WILKINSON

7/16/71

1

ON GOOSE COVE RESERVOIR (NORTH WEST END). BEGIN ON
SHINGTON ST. AT GEE AVE. TAKE GEE AVE. NORTHEASTERLY 0.40
CESS RD. TO DAM. TAKE ACCESS RD. NORTHERLY 0.40 MI. TO DAM.

CITY OF GLOUCESTER

WATER SUPPLY

EARTH WITH HEAVY STONE RIP RAP WATER SIDE

GATES OR OUTLETS

30.0 ± FT.

80.00

450.0 ± FT

20.0 ± FT.

NONE - THIS DAM FUNCTIONS AS
SIMPLE DIKE.

DAM IN GENERALLY EXCELLENT CONDITION

D 20 —
GLOUCESTER
5-5-107-15

L.E. WILKINSON

7/16/71

1

ON GOOSE COVE RESERVOIR. (NORTH END). BEGIN ON WASHINGTON ST. AT GEE AVENUE. TAKE GEE AVE. NORTH EASTERLY 0.40 MI. TO ACCESS RD. TO DAM. TAKE ACCESS RD. NORTHERLY 0.65 MI. TO DAM

CITY OF GLOUCESTER

WATER SUPPLY

EARTH WITH HEAVY STONE RIP RAP ON WATER SIDE
PIPE HOUSE WITH ONE VALVE ABOUT 50 FEET OFFSHORE FOR 36" CON
CRETE OUTLET.

35.0 ± FT.

80.00

315.0 ± FT.

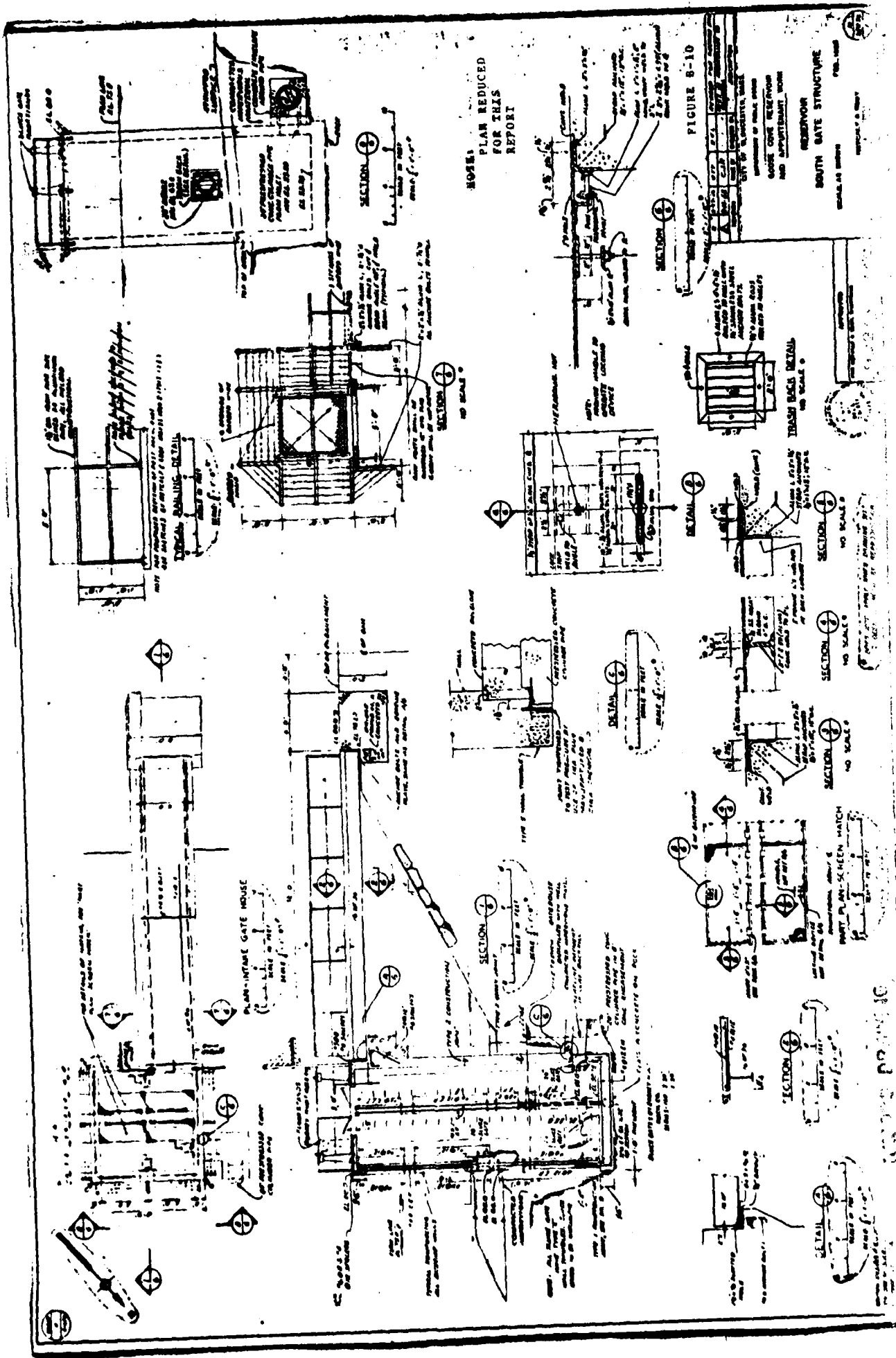
20.0 ± FT.

OUTLET AT END OF 36" PIPE.
CONCRETE WALLS AND BOTTOM GOOD

CONDITION, WATER FLOWING THRU WEST WALL VIA 8" TILE PIPE
ABOUT 2" DEEP. THRU EAST WALL THE SAME.
STEEL PROTECTIVE GRID OVER END OF 36" PIPE HALF TORN OFF
BY APPARENT VANDALS.

DAM GENERALLY IN EXCELLENT CONDITION.

GOOSE COVE RESERVOIR DAMS AND DIKES



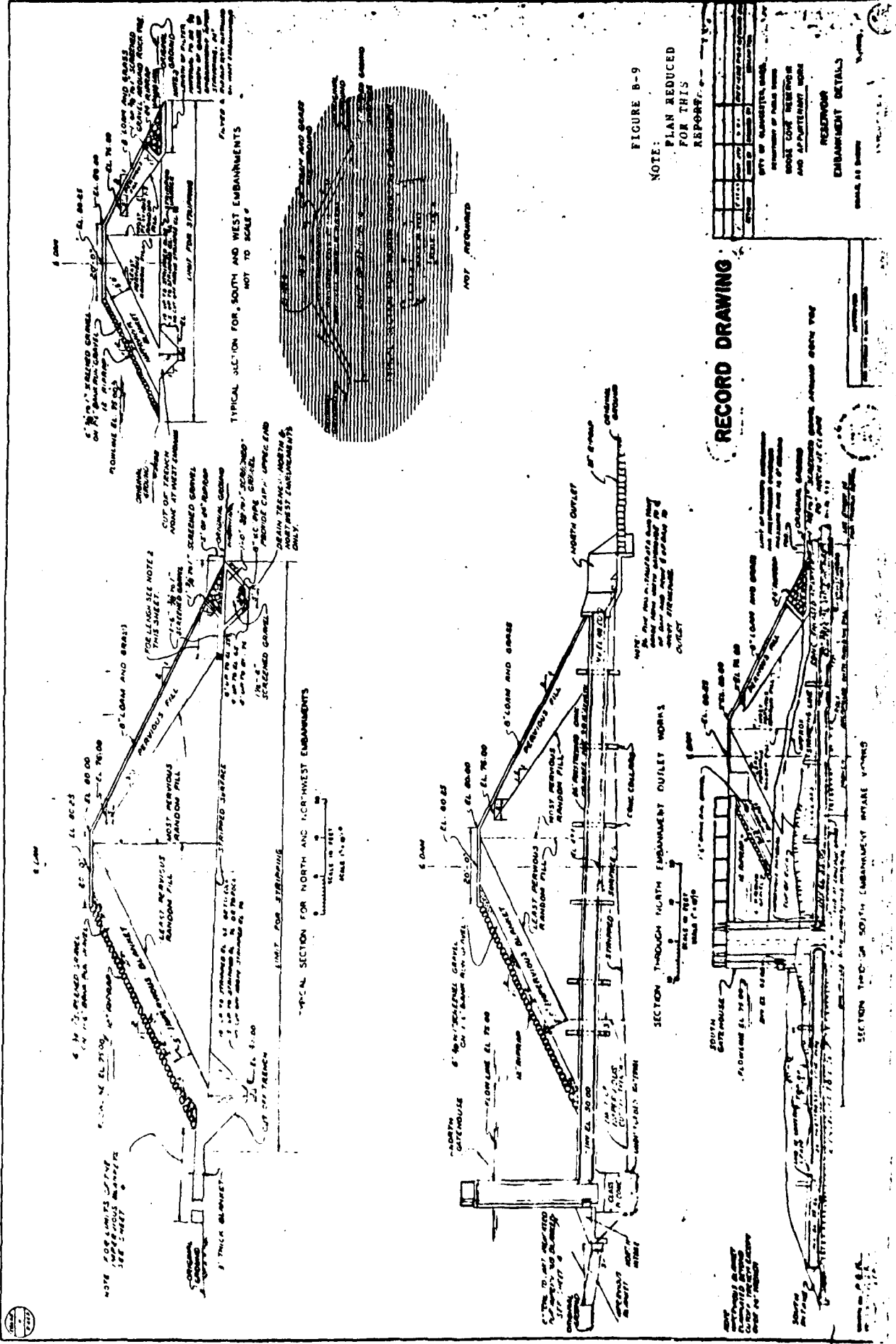
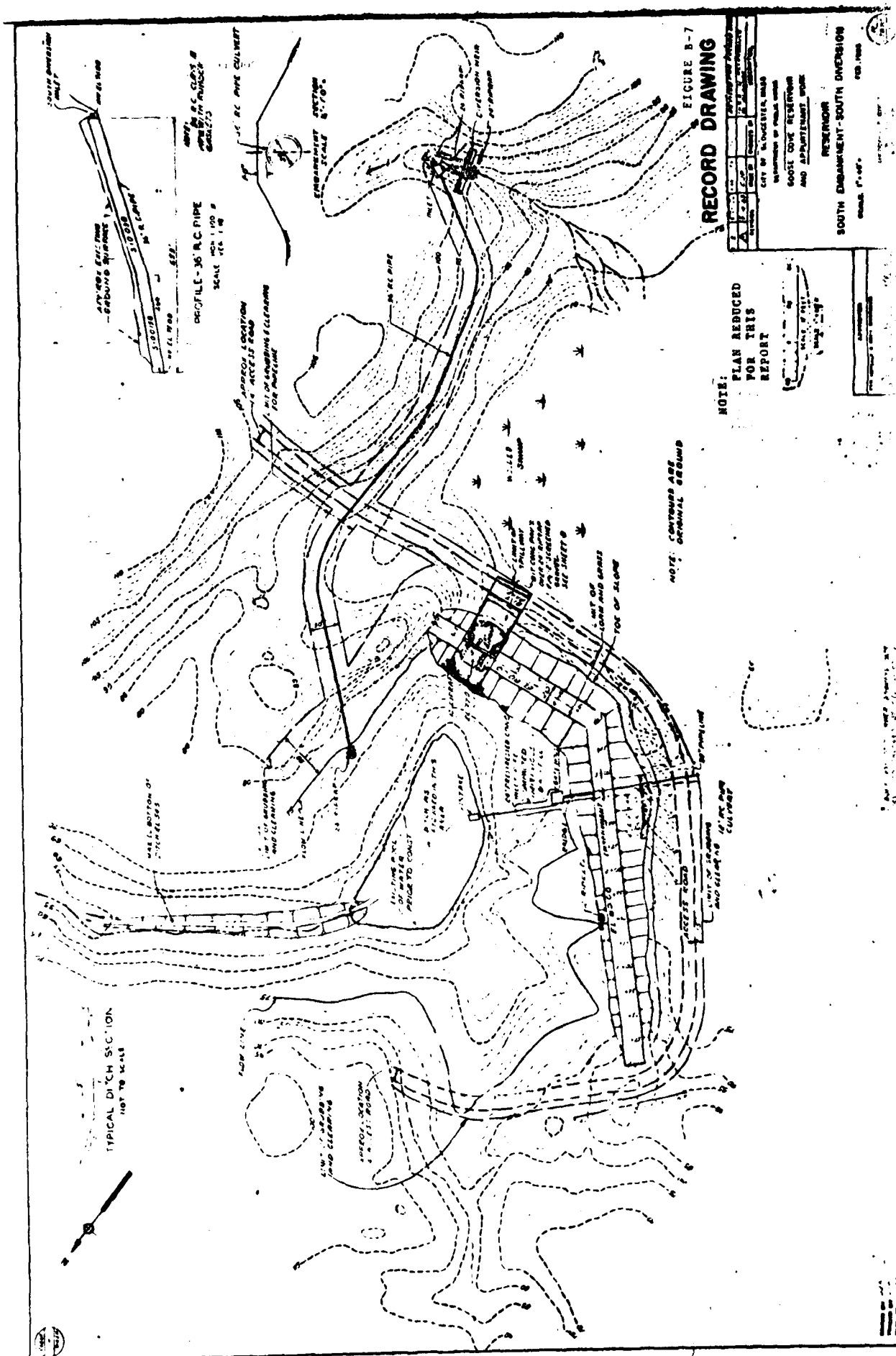
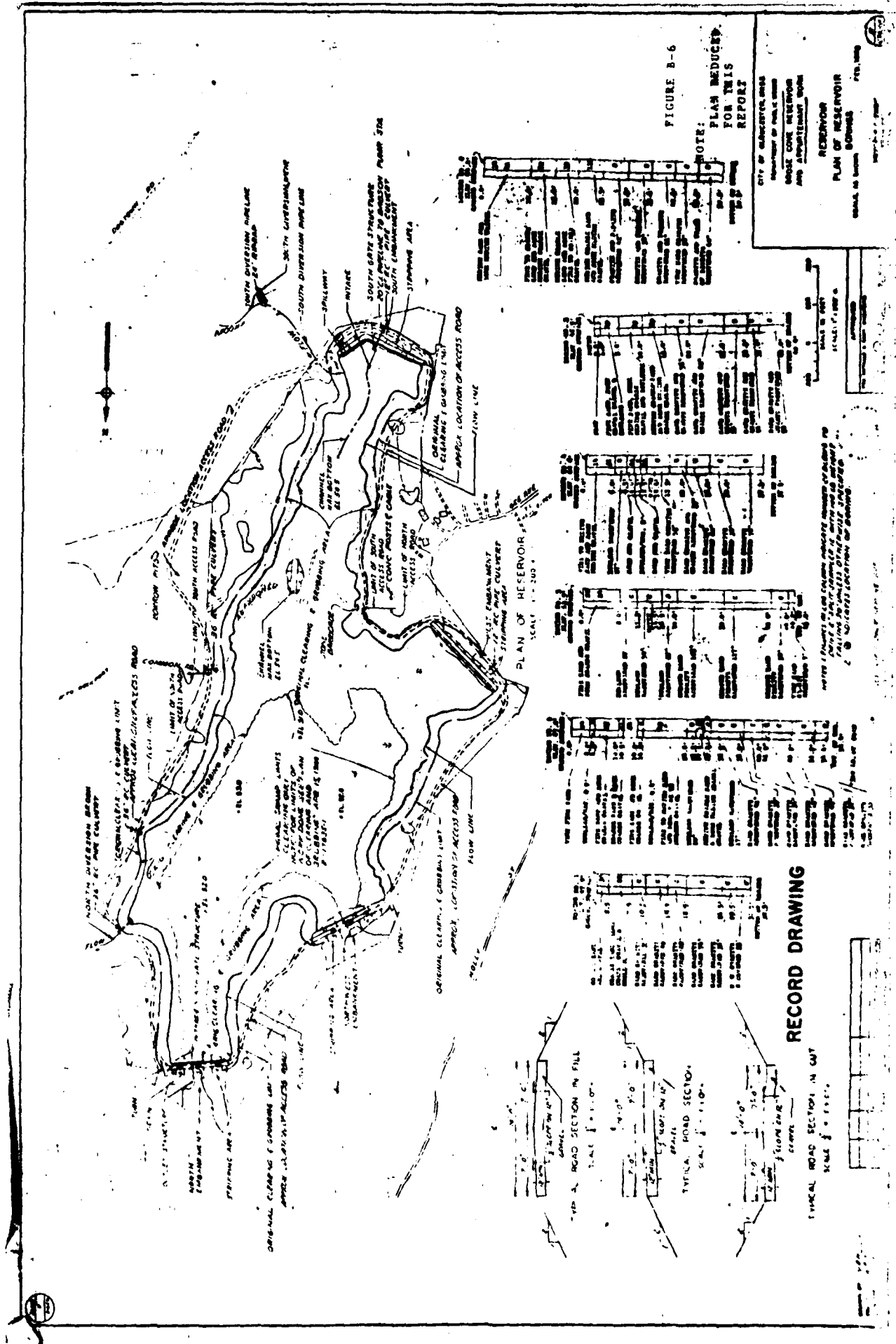


FIGURE B-9
 NOTE:
 PLAN REDUCED
 FOR THIS
 REPORT

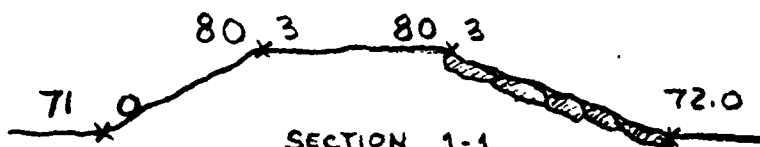
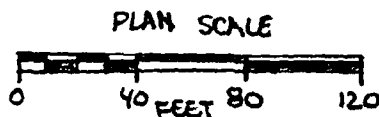
RECORD DRAWING

REVISION
 EMBANKMENT DETAILS
 SCALE: AS SHOWN

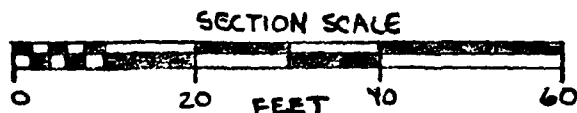




PLAN OF WEST EMBANKMENT



SECTION 1-1
WEST EMBANKMENT
HORIZONTAL SCALE 1 IN = 20 FT
VERTICAL SCALE 1 IN = 20 FT



NOTE:

1. Elevations shown based on embankment crest elevation 80.0 (NGVD) opposite South Embankment Gatehouse.
2. Information shown based on Field Inspection of November 21, 1980 and plans of "Goose Cove Reservoir and Appurtenant Work", February 1963, by Metcalf & Eddy, Engineers, Boston.
3. #12 indicates location and direction of view for photographs.



GOOSE COVE RESERVOIR

WATER
LEVEL
EL 60.6
(NGVD)

60X6

METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGL CORPS OF ENGINEERS BALTIMORE, MD.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAM	
GOOSE COVE RESERVOIR	
FIGURE B-5 PLAN AND SECTION OF SOUTHWEST DIKE	
TRIBUTARY ANNISQUAM RIVER	MASSACHUSETTS
SCALE: AS SHOWN	DATE: NOVEMBER, 1980



NO. 3 DROP INLET AT NORTH DAM



NO. 4 OUTLET STRUCTURE NORTH DAM



NO. 5 TOE DRAIN ON RIGHT WINGWALL NORTH DAM



**NO. 6 FILLED RUT ON DOWNSTREAM FACE OF
NORTHWEST DIKE**



NO. 7 CREST OF NORTHWEST DIKE



NO. 8 UPSTREAM SLOPE OF NORTHWEST DIKE



NO. 9 DOWNSTREAM CHANNEL—NORTHWEST DIKE



NO. 10 UPSTREAM FACE OF SOUTH DAM

C-5

GOOSE COVE RESERVOIR DAMS AND DIKES



NO. 11 TIRE RUTS ON DOWNSTREAM FACE OF SOUTH DAM



NO. 12 RIPRAP ON UPSTREAM FACE OF SOUTH DAM



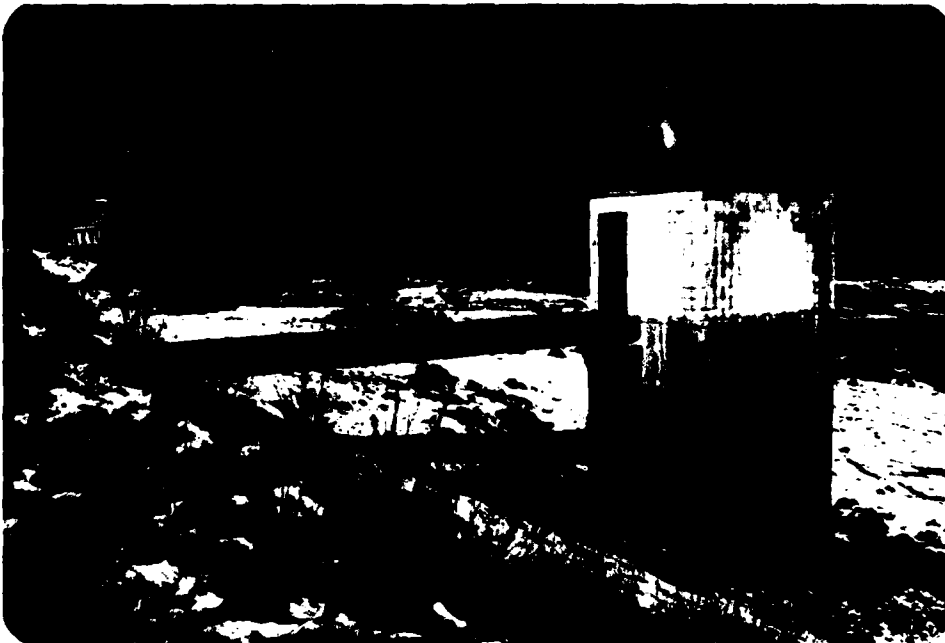
NO. 13 TOE DRAIN ON SOUTH DAM



NO. 14 SPILLWAY SOUTH DAM

C-7

GOOSE COVE RESERVOIR DAMS AND DIKES



NO. 15 GATEHOUSE AND SERVICE BRIDGE SOUTH DAM



NO. 16 UPPER INLET SOUTH DAM



NO. 17 DOWNSTREAM CHANNEL SOUTH DAM



NO. 18 CREST OF SOUTHWEST DIKE



**NO. 19 TIRE RUTS ON DOWNSTREAM FACE OF SOUTHWEST
DIKE**

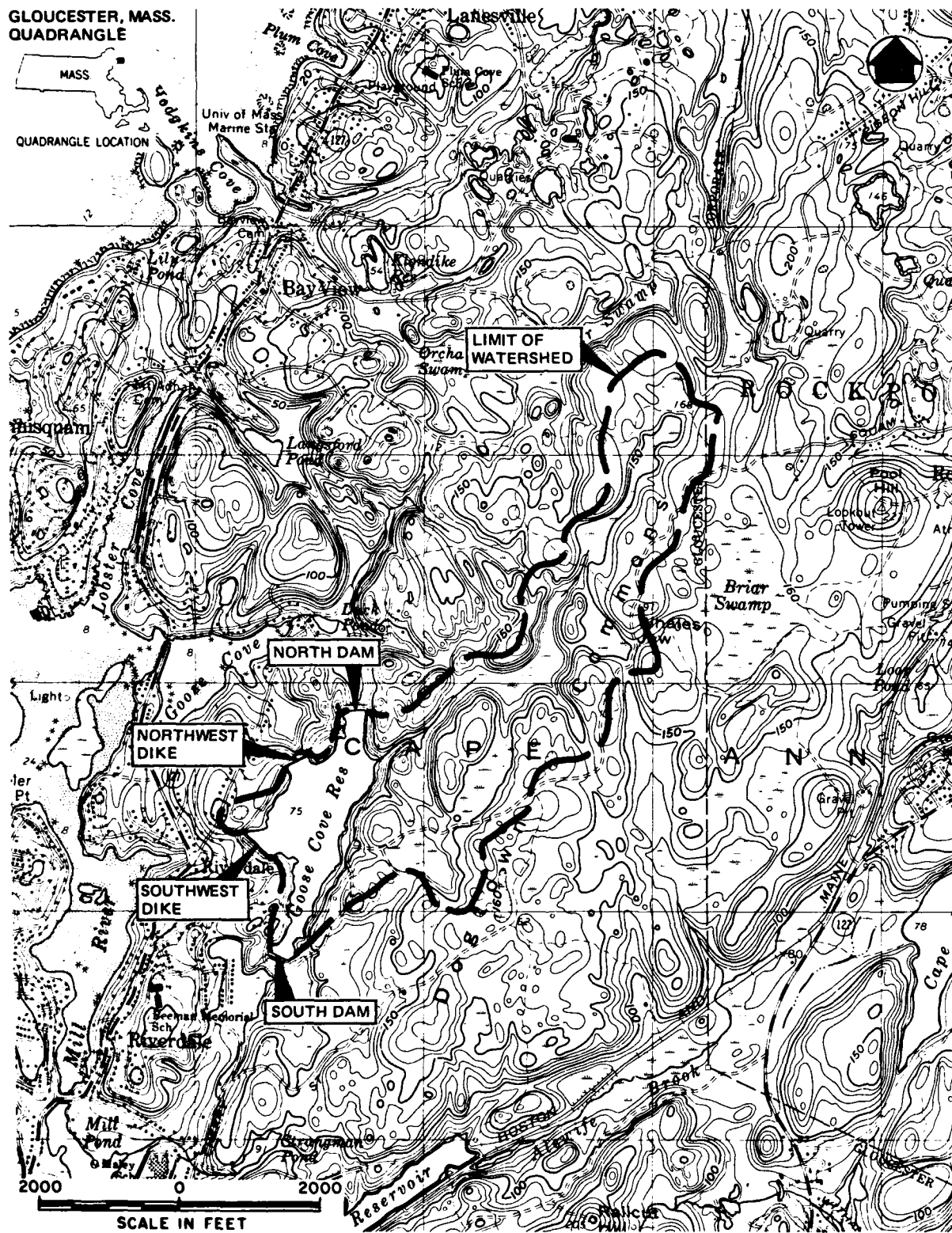


NO. 20 UPSTREAM FACE OF SOUTHWEST DIKE

APPENDIX D

HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

	<u>Page</u>
Figure D-1, Drainage Area Map	D-1
Hydrologic and Hydraulic Computations	D-2



GOOSE COVE RESERVOIR DAMS
GOOSE COVE RESERVOIR DIKES

I. TEST FLOOD, STORAGE & STORAGE FUNCTION

A. The total drainage area is 0.659 sq. mi

B. Area of ponds 0.0 sq mi
 Area of swamps 0.080 sq mi
 total 0.080 sq mi

% of ponds & swamps $\frac{.08}{.659} \times 100 = 12.1\%$

C. Average slope of watershed

$$\frac{168 - 75}{7200} = \frac{93}{7200} = .0129 \times 100 = 1.3\%$$

D. Using the USCE curves for peak flow rates along with the above information, the peak flow rate was established between rolling and flat & coastal. The value used was

$$1175 \text{ cfs/sq mi}$$

Size class: intermediate } Test Flood is Full PMF
 Hazard Potential: high

E. Test Flood Inflow $(1175 \text{ cfs/sq mi})(0.659 \text{ sq mi}) = 774 \text{ cfs}$

F. Pond Storage: The pond area is 65.1 ACRES (.102 sq mi) at El 80. Based on a constant area, storage increases at 65.1 ac-ft per foot of depth increase above El. 80.

G. The low point on the main spillway crest:

Goose Cove North Dam El 75.0
 The crest elevation of the emergency spillway:
 Goose Cove South Dam El. 78.0

H. The storage function is based on $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

S_{out} = Storage volume in reservoir related to Final Q_{out} in terms of inches of rain over the drainage area.

Project: USCE DAM INSP Acct. No. J7252 Page 2 of 11
 Project: ESSEX COUNTY Comptd. By M. NOWAK Date 12-10-80
 Title: GOOSE COVE RESERVOIR Ch'd. By MEM Date 12/22/80

$$S(\text{inches}) = 12 D \left(\frac{.094 \text{ sq mi}}{.659 \text{ sq mi}} \right) = 1.71 D$$

R = 6 HR. RAIN of STORM @ 19 inches

D = Storage depth in feet above spillway crest in reservoir.

Storage Function: FULL PMF and HALF PMF

$$\begin{aligned} \text{PMF: } Q_{\text{out}} &= 774 - 40.7 S = 774 - 69.6 D \\ \frac{1}{2} \text{ PMF: } &= 387 - 40.7 S = 387 - 69.6 D \end{aligned}$$

I. DISCHARGE RATINGS

① NORTH DAM, OVERFLOW SPILLWAY Crest El. 75.0

4 sides @ 5' per side 20 ft
 11 track racks @ 0.75" ϕ - 2.75 ft

Net spillway length is 17.25 ft

$$Q_1 = 3.00 (17.25) H_1^{1.5} = 51.75 H_1^{1.5}$$

RES. EL	H ₁	(Q ₁ , CFS)
75	0	0
76	1	52
77	2	146
78	3	269
79	4	414
80	5	579

② 36" DRAIN TO BROOK

$$A = \pi (3^2/4) = 7.07 \text{ sq ft}$$

L = 145.6' & OUTLET EL at 50.0 (NGVD)

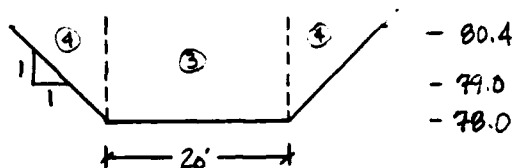
$$H_2 = \frac{V^2}{2g} \left\{ \underset{\substack{\downarrow \\ \text{entr.}}}{0.5} + \underset{\substack{\downarrow \\ \text{out}}}{1.0} + .022 \left(\frac{145.6}{3} \right) \right\}$$

$$H_2 = 2.57 \frac{V^2}{2g} \Rightarrow V = 5.01 \sqrt{H_2}$$

$$Q_2 = VA = 35.4 \sqrt{H_2}$$

RES. EL.	H ₂	Q ₂ (cfs)
75	25	177
76	26	181
77	27	184
78	28	187
79	29	191
80	30	194
80.1	30.1	194

B. SOUTH DAM, EMERGENCY SPILLWAY



$$Q_3 = 3.0 L H_3^{1.5}$$

$$* Q_4 = 2.5 L H_4^{2.5}$$

RES. EL.	H _{3,4}	Q ₃	Q ₄	Q _{TOTAL}
78.0	0	0	0	0
78.5	.5	21	0	21
79.0	1.0	60	2	62
79.5	1.5	110	6	116
80.0	2.0	170	14	184
80.1	2.1	183	16	199
80.2	2.2	196	18	214

* From "OPEN CHANNEL FLOW"
by HENDERSON, p 178

C. CREST FLOW - Low point is on South Embankment

H is the average head

$$Q = 2.55 L H^{1.5}$$

Res. Elev.	L	H	L	H	L	H	Q(cfs)	
80.1	67	.05					2	(South Embankment)
80.2	67	.15	70	.05			15	(South Embankment)
80.3	67	.25	70	.15	985	.1	110	(South, North & Northwest Embankments)

AD-A155 799

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
GOOSE COVE RESERVOIR. (U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV APR 81

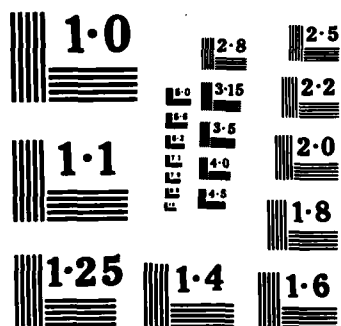
2/2

UNCLASSIFIED

F/G 13/13

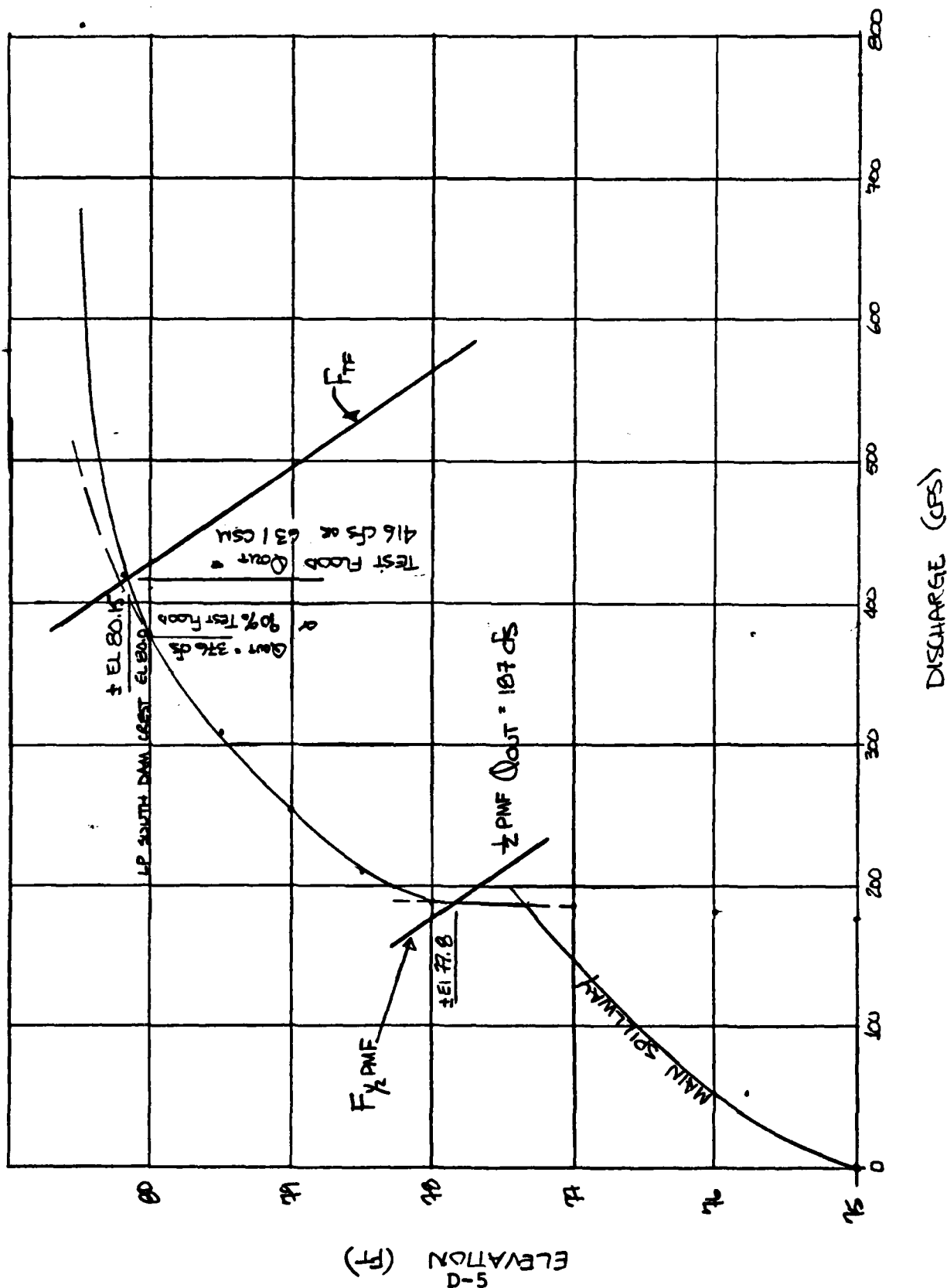
NL





NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

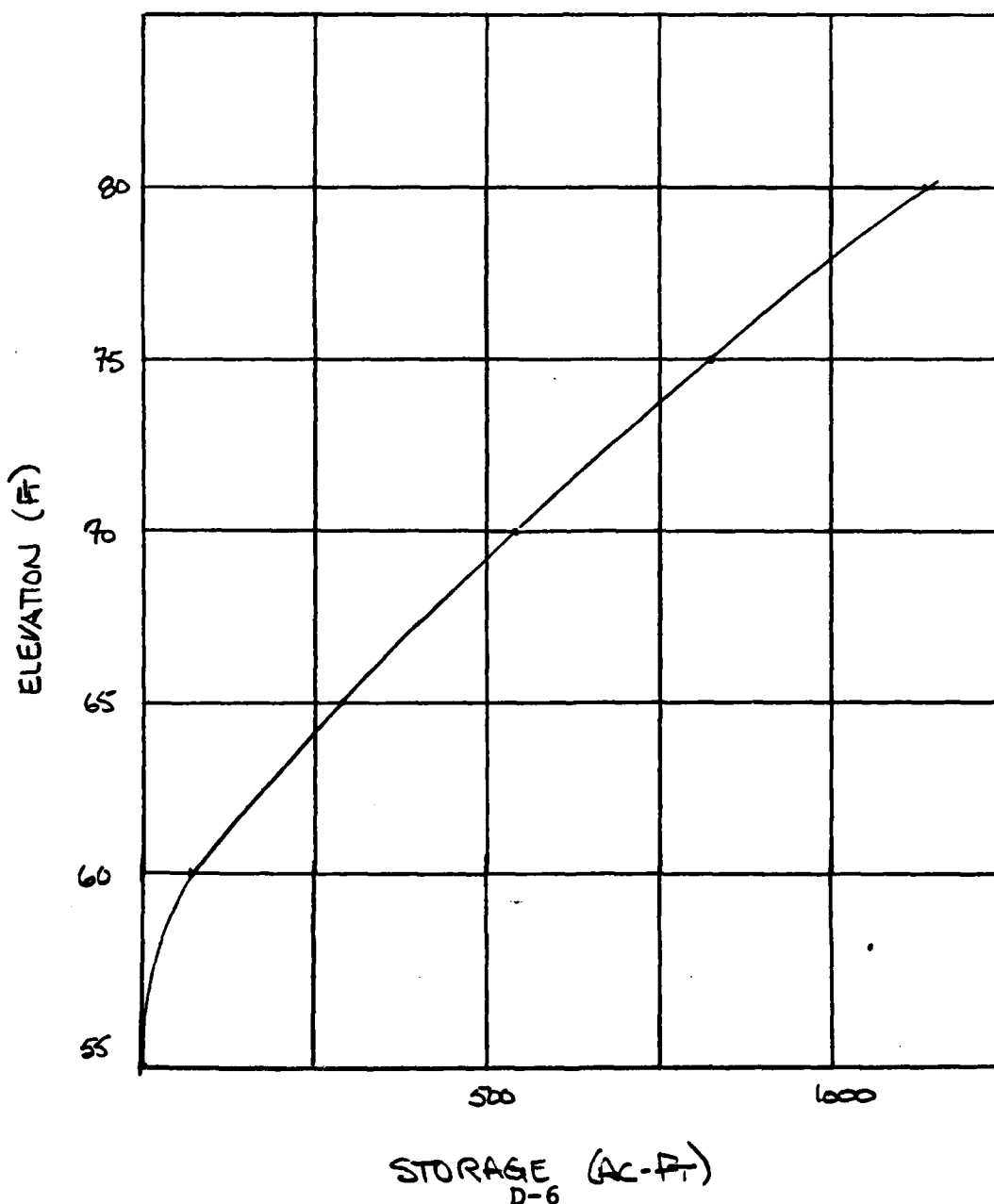
METCALF & EDDY, ENGINEERS



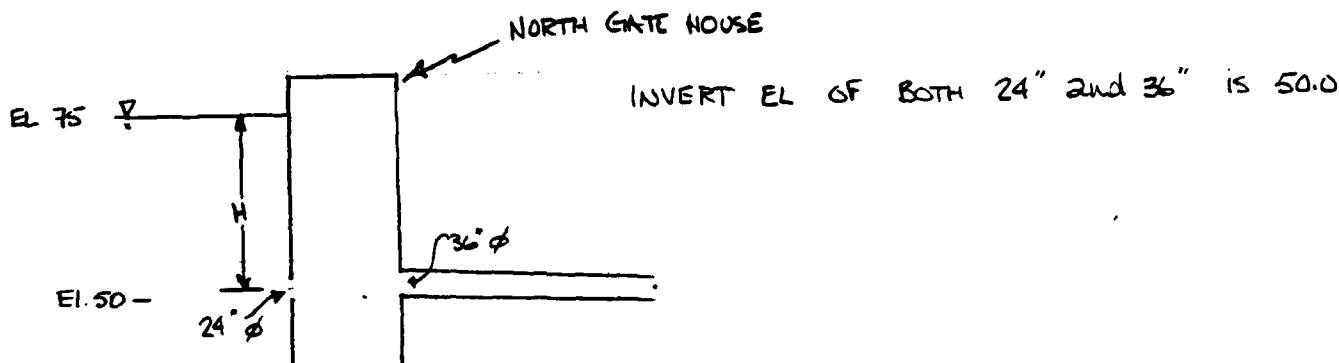
Project USCE DAM INSP Acct. No. 7252 Page 5 of 11
 Subject ESSEX COUNTY Comptd. By M. NOWAK Date 12-10-80
 Detail GOOSE COVE RESERVOIR Ch'd. By MEM Date 12/22/80

VI. STORAGE IN GOOSE COVE RESERVOIR

RES. EL. (FT)	SURF. AREA (ACRES)	RES. VOL (AC-FT)
54.5		0
60	41.7	69.5
65	47.1	291.5
70	53.2	542.3
75	59.9	825.1
80	65.1	1137.6



IV LOW LEVEL OUTLET



At 24" orifice, $Q = 0.60 A \sqrt{2gH}$

To lower the reservoir one foot from EL 75 to EL 74:

EL 75 $Q = \frac{.6 \pi (2)^2}{4} \sqrt{(2)(32.2)(24)} = 74.1 \text{ CFS}$

EL 74 $Q = \frac{.6 \pi (2)^2}{4} \sqrt{(2)(32.2)(23)} = 72.5 \text{ CFS}$

average $Q = \frac{74.1 + 72.5}{2} = 73.3 \text{ CFS}$

Time needed to drain reservoir one foot:

VOLUME AT EL. 75	825.1 AC-Ft
VOLUME AT EL. 74	768.54
	56.56 AC-Ft

$$\frac{56.56 \text{ AC-Ft}}{(73.3 \text{ CFS}) \left(1.48 \frac{\text{AC-Ft}}{\text{CFS}} \right)} \times \frac{24 \text{ HRS}}{1} = 9.4 \text{ HRS}$$

V CREST FLOW - OVER SOUTH EMBANKMENT ONLY
 PEAK T.F. ELEV - L.P. CREST ELEV = 80.15 - 80.0 = 0.15 Ft (MAX HEAD)

UNIT FLOW = $q = 2.55 (0.15)^{1.5} = 0.15 \text{ cfs/ft}$
 AS CRITICAL FLOW

$Y_c = (q^2/g)^{1/3} = .09 \text{ Ft} ; V_c = 1.67 \text{ fps}$
 D-7

VII DAM FAILURE

NORTH EMBANKMENT

Width of dam subject to failure is 315 ft

$$W_0 = 40\% (315') = 126 \text{ ft}$$

Res. elev. at low point, crest	EI. 80.0 ft
Average toe elev.	EI. <u>56.0 ft</u>
y_0	<u>24.0 ft</u>

The peak failure flow is calculated as:

$$Q = 1.68 W_0 y_0^{1.5}$$

$$= 1.68 (126)(24.0)^{1.5} = 24900 \text{ cfs}$$

Storage volume released

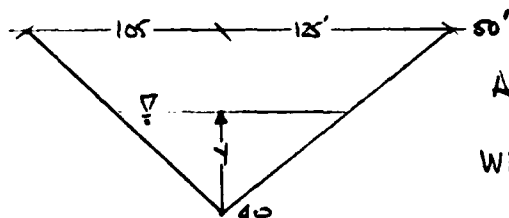
at EI 80.0	1137.6 AC-FT
at EI 56.0	<u>0</u>
	1137.6 AC-FT

CHANNEL HYDRAULICS

Slope of channel into Duck Pond is $\frac{50'-25'}{1150'} = .0217$

$$Q = (1.49/\eta) A R^{2/3} S^{1/2} \quad \text{where } \eta = .08$$

Cross section at contour 40:



$$A = \frac{1}{2}(12.5)y^2 + \frac{1}{2}(10.5)y^2 = 11.5y^2$$

$$WP = (12.5y + 10.5y) = 23.0y$$

$$Q = \frac{1.49}{.08} (11.5y^2) \left(\frac{11.5y^2}{23.0y} \right)^{2/3} (.0217)^{1/2} = 2.746 (11.5y^2) (.5y)^{2/3}$$

y	Q cfs
2	130
3	370
5	1450
12	15020
14	22650
15	27220

Project USCE DAM INSP, PH1 Acct. No. J 7252 Page 8 of 11
 Subject ESSEX COUNTY Comptd. By M. NOWAK Date 12-10-80
 Detail GOOSE COVE RESERVOIR Ch'd. By MFM Date 12/23/80

Based on this, failure of the North Dam will increase the water surface elevation in the downstream channel from from 2.5 feet to 14.5 feet.

NORTHWEST EMBANKMENT

Width of dam subject to failure is 472'

$$W_0 = 40\% (472') = 189'$$

Res. elev at low point of crest	E1	80.0 ft
Bottom of reservoir	E1	54.5 ft
$y_0 =$		25.5 ft

The peak failure flow is calculated as:

$$Q = 1.68 W_0 y_0^{1.5}$$

$$= 1.68 (189) (25.5)^{1.5} = 40,890 \text{ cfs}$$

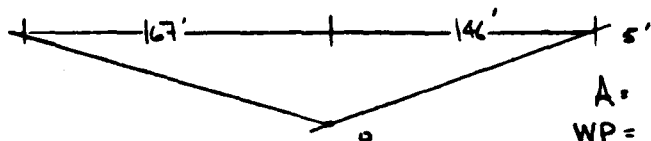
Storage Volume Released

at E1 80.0	1137.6	AC-FT
at E1 54.5	0.0	
	<u>1137.6</u>	AC-FT

CHANNEL HYDRAULICS

Slope of channel to Goose Cove is $\frac{10'}{833'} = .0120$

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} \quad \text{where } n = 0.08$$



$$A = \frac{1}{2} (29.2) y^2 + \frac{1}{2} (33.4) y^2 = 31.3 y^2$$

$$WP = 62.6 y$$

$$Q = \frac{1.49}{.08} (31.3 y^2) \left(\frac{31.3 y^2}{62.6 y} \right)^{2/3} (.0120)^{1/2}$$

$$= 2.04 (31.3 y^2) (.5 y)^{2/3}$$

y	Q (cfs)
5	2940
10	18670
13	37600 ←
14	45820
15	55070

Based on this, Failure of the Northwest Dam will increase the water surface elevation from zero (no discharge) to 13.4 feet of water in the downstream channel.

SOUTH EMBANKMENT

Width of dam subject to failure is 192 feet. (from gatehouse to spillway)

$$W_o = 40\% (192') = 76.8 \text{ feet}$$

Res. elev. at low point crest	El. 80.0
Bottom of upstream slope	El. 67.5
y_o	12.5 ft

The peak failure flow is calculated as:

$$Q = 1.68 W_o y_o^{1.5}$$

$$= 1.68 (76.8) (12.5)^{1.5} = 5700 \text{ cfs}$$

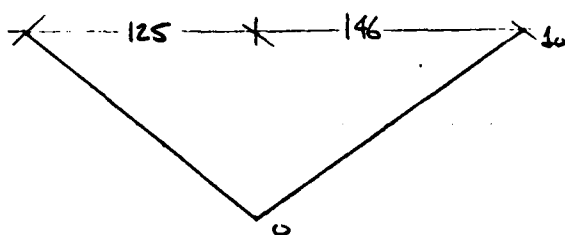
Storage volume released:

at El 80.0	1137.6 AC-Ft
at El 67.5	416.9 AC-Ft
	<u>720.7 AC-Ft</u>

CHANNEL HYDRAULICS

Slope of channel below bridge $\frac{40-11.5}{1770} = .0161$

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2} D-10 \quad n = 0.08$$



$$A = \frac{1}{2}(12.5)y^2 + \frac{1}{2}(14.6)y^2 = 13.6y^2$$

$$WP = (12.5y + 14.6y) = 27.1y$$

$$Q = \frac{1.49}{.08} (13.6y^2) \left(\frac{13.6y^2}{27.1y} \right)^{2/3} (.0161)^{1/2}$$

$$= 2.363 (13.6y^2)(.5y)^{2/3}$$

y	Q (cfs)
2	130
3	380
5	1480
8	5182
9	7095
10	9397

Based on this, failure of the South Dam will increase water surface elevation from 2.5 feet to 8.2 feet in the downstream channel.

SOUTH WEST EMBANKMENT

Width of dam subject to failure is 524 feet.

$$W_o = 40\% (524') = 210 \text{ ft}$$

Res. elev. at low point, crest
 Bottom of upstream slope
 y_o

El. 80.0
 El. 72.0
 8.0 Ft

The peak failure flow is calculated as

$$Q = 1.68 W_o y_o^{1.5}$$

$$= 1.68 (210)(8.0)^{1.5} = 7980 \text{ cfs.}$$

CHANNEL HYDRAULICS

Flow out of West Dike will be like overland flow

$$Q = 2.55 L H^{1.5}$$

Approximate channel width, $L = 290$ ft

$$Q = (2.55)(290) H^{1.5} = 740 H^{1.5}$$

H	Q(cfs)
1	740
2	2090
3	3840
4	5920
5	8270

Based on this, failure of the West Dike will increase the water surface elevation in the discharge channel from zero (no discharge) to 4.8 feet.

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

GOOSE COVE RESERVOIR DAMS AND DIKES

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

DTIC